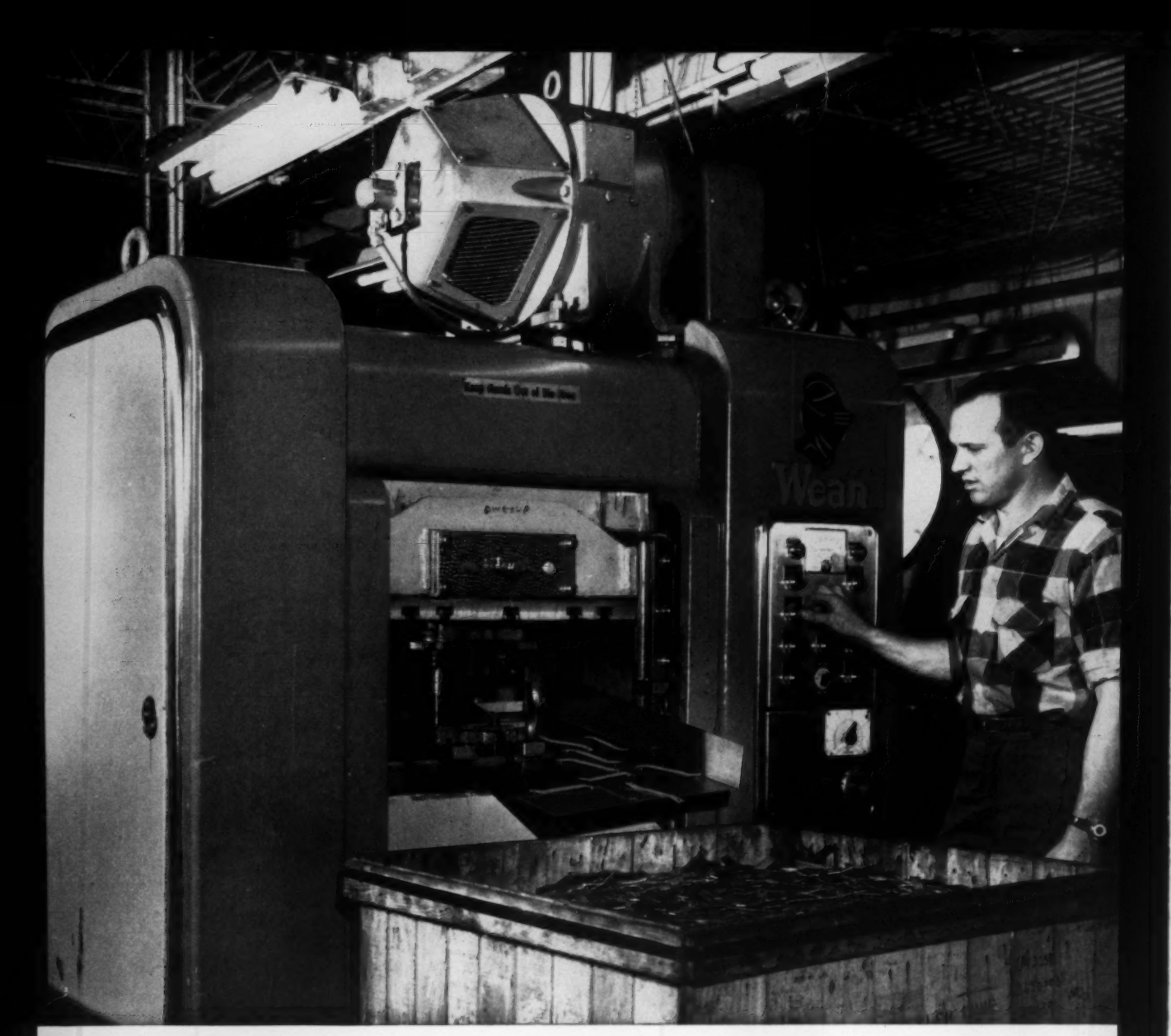
AUTOMATION

JUNE 1957

Automatic Testing

The Magazine of Automatic Operations



Is the Wean "Flying Press"

the fastest press in the world?

WE THINK IT IS. While our top speeds have stayed around 600 strokes per minute on the "flying press," the size of piece is not restricted to washers and the like which are made on other high speed presses.

For example, where conventional presses rarely can process more than 100 feet of metal per minute, the "flying press" has performed at speeds in excess of 300 feet per minute.

One new model, for instance, blanks automotive assemblies 8 feet long at 45 per minute.

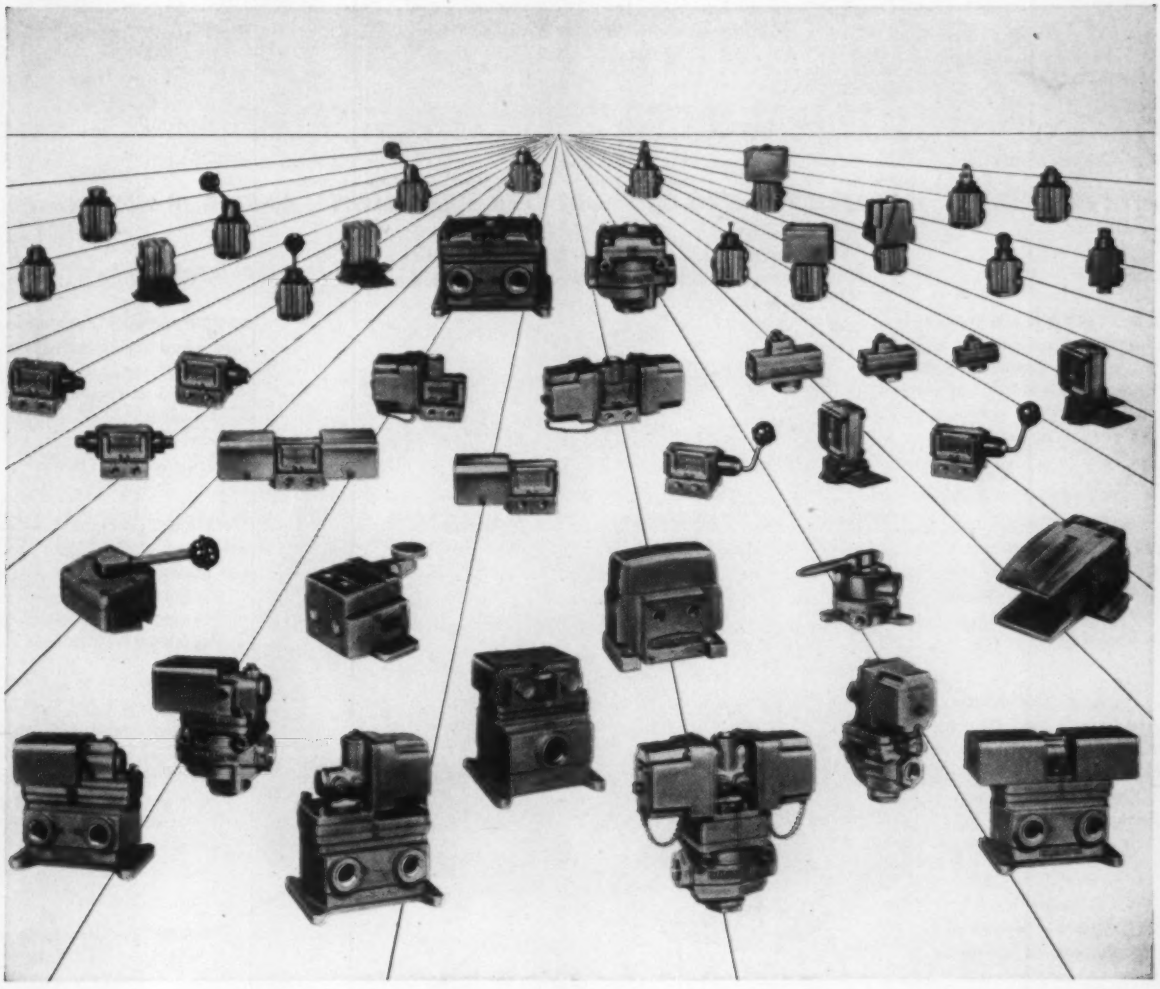
Yet, the "flying press" has other major advantages for you. Despite its revolutionary construction, it requires up to 20% less maintenance than other presses — it has no brake or clutch to wear. And, because of almost perfect dynamic balance, the press can be floor mounted.

We could write a book about the features of the Wean "flying press" — in fact we have. It's soon to be released . . . and it's yours for the asking. Write to the address below. We will mail your copy of the Wean "Flying Press" brochure as soon as it comes from the printers.

Wean Equipment Corporation

CLEVELAND 17, OHIO

Circle 651 on Inquiry Card



These valves like tough jobs

Discriminating engineers are finding that out. More and more of them are specifying Hannifin valves for every kind of directional air control—including the really tough jobs.

There are plenty of reasons why: Inspired simplicity of design. Fewer parts—and *those* easily and quickly replaceable. Ability to serve a wide range of applications with fewer valve models. And—above all—fast, smooth operation.

Your Hannifin man will gladly give you the whole story. We'll tell you where to get in touch with him—after you examine the big Hannifin catalog.

AIR CONTROL

HANNIFIN

VALVES

***For this complete catalog** showing all the Hannifin directional air control valves, write to Hannifin Corporation, 541 South Wolf Road, Des Plaines, Illinois.*

Circle 654 on Inquiry Card

NEW! CLARK Type "AL" AUTOMATION CAM LIMIT SWITCH

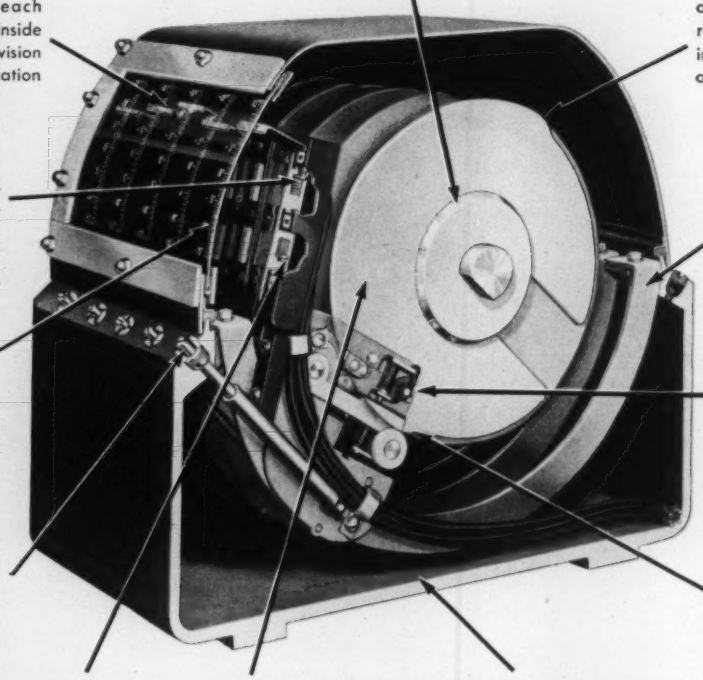
— ADJUSTABLE IN MOTION —

GREATER SAFETY! GREATER FLEXIBILITY! GREATER PRECISION! EASIER MAINTENANCE!

PRECISION—Cams can be loosened and reset without removing them from shaft. Graduations facilitate making precise settings.

PRECISION—Graduated scales for adjustment of each switch unit are printed on inside of clear plastic window. Provision is made for circuit identification visible through window.

SAFETY—Switch unit is actuated only when roller is riding on raised segment of cam. Jogging in reverse does not alter sequence of operations.



FLEXIBILITY—An additional isolated contact—easily convertible in the field—is available for each switch unit, to permit control of two circuits from a single unit.

FLEXIBILITY—Rear-mounted switch units can be added to permit micro-adjustment of both make and break of a single circuit operated by a single cam.

MAINTENANCE—All contacts clearly visible through plastic window. Inspection may be made without removing switch cover.

PRECISION—Snap-action, latching type switch units make possible smooth performance, being operated by constant acceleration cams eliminating "bumping".

PRECISION—Position of switch unit can be adjusted to micro-accuracy over a 30° range from outside housing *while machine is in motion.*

SAFETY—Cams force contacts open and hold them open—assuring postive break.

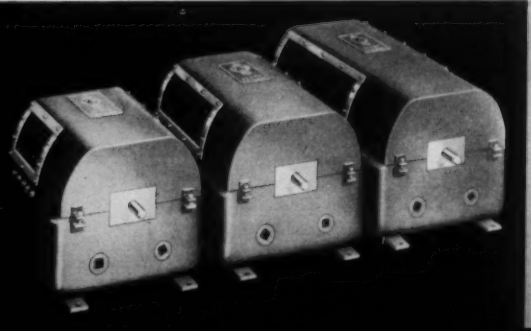
SAFETY
Heavy-duty 15 ampere industrial-control type contacts will not jar open with severe vibration.

PRECISION
Large (7-in.) twin-disc adjustable butterfly cams operate each circuit. Wide variety of cam equipment available to cover range of contact operations from 15° to 345°.

MAINTENANCE—Enclosure with cast aluminum base and welded steel cover meets NEMA 4 (watertight) and NEMA 12 (automotive and J.I.C.) standards. Oil resistant rubber gasketing and packing under pressure completely seal enclosure.

These new CLARK Type "AL" Cam Limit Switches meet the rugged requirements of large presses, and have broad application on many other machines where accurate and dependable sequence operation of multiple circuits is required. They are ideal for use where it is advantageous to make precision adjustments while machines are in motion, and are particularly suitable for many applications in the field of Automation.

3 basic sizes: 5 cam, 9 cam and 12 cam. The 12-cam size can be modified to accommodate up to 16 cams. With double-sided switch arrangements, each size can provide additional switch units up to one less than the number of cams.



For more information, write for Bulletin 102-AL

The **CLARK** **CONTROLLER** *Company*

Everything Under Control 1146 East 152nd Street • • Cleveland 10, Ohio

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JUNE 1957
Vol. 4—No. 6

AUTOMATION

A PENTON PUBLICATION

The Magazine of Automatic Operations

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←Circle 655 on Inquiry Card

automation outlook

DEVELOPMENT TIME

". . . the change from laboratory devices to reliable production units, which have been checked adequately in the laboratory and in the field, requires a much greater length of time than most of us realize. We have transistors with truly remarkable characteristics in the laboratories but anywhere from a year to two years will be required to move them out as standardized, reproducible, reliable components which can be trusted in Safety Service communications systems. . ."—*Daniel E. Noble, vice president in charge of Communications and Electronics Div., Motorola Inc.*

HUMAN DIGNITY

". . . far from competing for desirable jobs now done by men, the devices of automation will relieve human beings of tasks which are either beyond the scope of human performance or beneath human dignity . . ." —*Louis N. Ridenour, director of research, Lockheed Aircraft Corp.*

DOMINANT GROUP

". . . by 1975, professional personnel may account for one out of every 8 workers, a third higher than the proportion today. The white collar group, which includes clerks, salespeople, managers and owners, as well as the professionals, are expected to be the dominant occupational group, with 44 per cent of the labor force . . ."—*Rocco C. Siciliano, Assistant Secretary, U.S. Department of Labor.*

FEASIBILITY STUDY

". . . economic feasibility must be examined in considering nearly any industrial project. This point is at least as important to the consideration of projects dealing exclusively with automation proposals as it is to any other particular type of industrial project. In fact, it might be considered even more important in discussion of automation projects since the greatest benefits from automation often result from very broad planning involving extensive modifications or large-scale new investments in facilities . . ."—*E. Ralph Sims, Jr., Alden E. Stilson & Associates, Ltd., see page 54.*

HAND LABOR OUT

". . . it is interesting to note the labor saving virtues of this machine. The operator in one eight-hour shift handles over five tons of networks —easily and without fatigue. Testing would not be attempted on a manual basis because over and above multiple handlings, the added human effort of closing fixtures, operating switches and the like could not be tolerated . . ."—*D. T. Robb, engineer, Western Electric Co., see page 64.*

ONE ANSWER

". . . now there is one, and only one, great answer to the problems created by competition and the threat to our security. That answer is productivity. Productivity is the means by which we in the manufacturing industry can lower our production costs to meet the challenge of our competitors . . . and productivity can provide this nation with the kind of defense power that it needs to deter the threat of aggression . . ."— *Delmar S. Harder, executive vice president, Ford Motor Co.*

AUTOMATION

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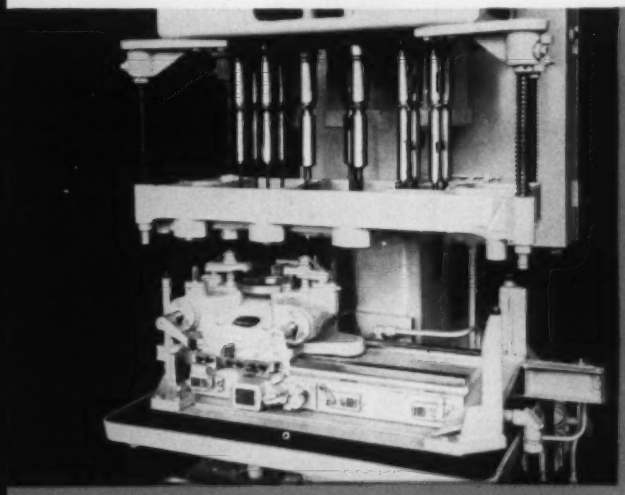
BPA NBP

Natco Naturals

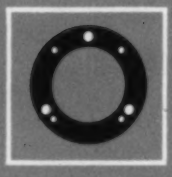
Cost-Cutting Ways
You Can Use
Standard Multi-Spindle Natcos

Any time your parts require machining *more than one hole*–drill, bore, face or tap–it may well be a "Natco Natural." Your standard Natco will produce substantial savings in a surprising number of situations, *even in small job-shop lots!* Call in your nearby Natco field engineer; he'll tell you in short order whether you've got a "Natco Natural" there.

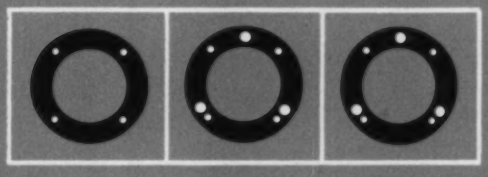


Multiple Drilling Operations on One Part-Face

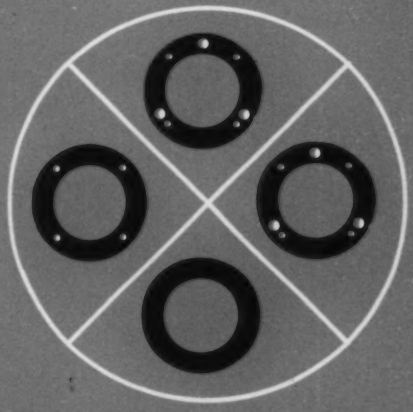
Straight-line indexing *on a Natco H6 produces 49 parts per hour. 4 holes drilled in first position, 3 holes drilled in second position, 4 holes c'bored in third position. One part completed every three strokes. Automatic cycling frees operator for other work. Illustrations below show three other ways of handling this part.*



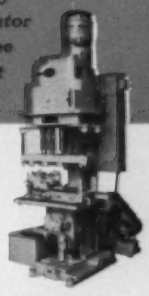
45 parts per hour. *Inexpensive box jig. Operator positions jig under appropriate spindles. One complete part for 3 strokes of machine.*



75 parts per hour. *3-position fixture. Operator shifts parts after each stroke. One part completed every stroke.*



133 parts per hour. *Rotary 4-position index table. Operator unloads and loads while three operations proceed. One part completed every stroke.*



Standard multi-spindle Natcos *range from 1 hp, 10-spindle machines to 25 hp machines with up to 72 spindles. Spindles in standard Natcos are driven through universal joints and located by either adjustable arms or bored slip plates.*

NATCO

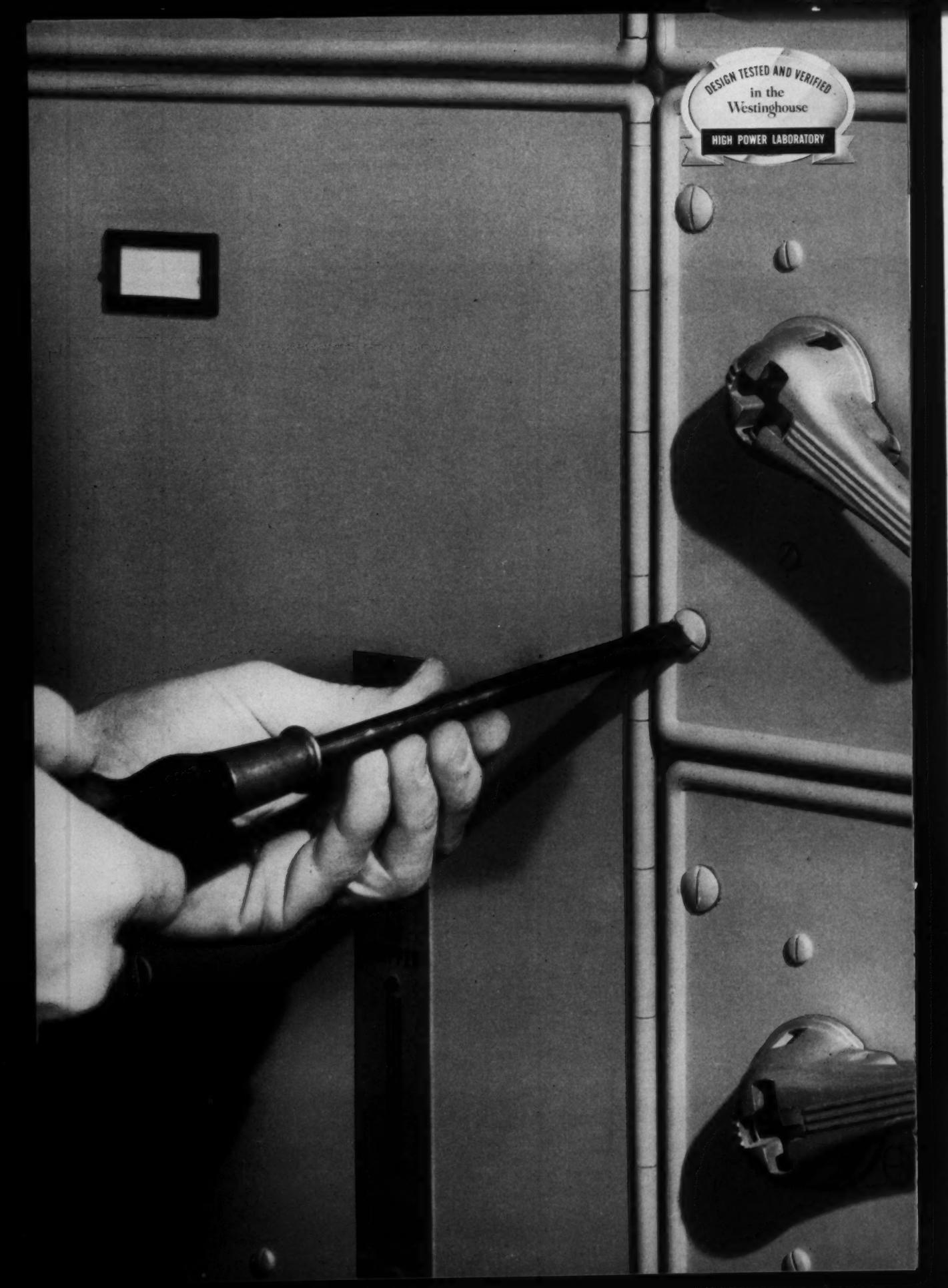
National Automatic Tool Company, Inc.

Richmond, Indiana

Multi-spindle drilling, boring, facing & tapping machines. Special machines for automatic production.

Call Natco Offices in Chicago, Detroit, New York, Buffalo, Boston, Philadelphia, Cleveland, Los Angeles; distributors in other cities.

Circle 656 on Inquiry Card


DESIGN TESTED AND VERIFIED
in the
Westinghouse
HIGH POWER LABORATORY

Now Westinghouse announces complete control center flexibility

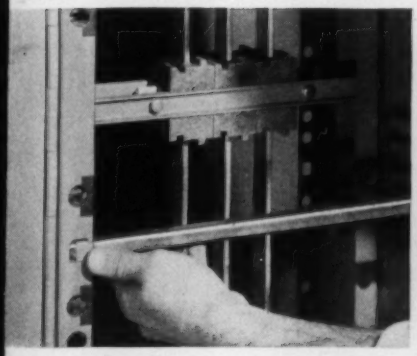
New design meets changing requirements with both 14- and 9⅓-inch modular units

From the new 9⅓-inch units to the dependable electrical components, the new Westinghouse control center is designed to meet your present requirements and future needs. Both the 14-inch and 9⅓-inch units can be quickly interchanged within a standard structure.

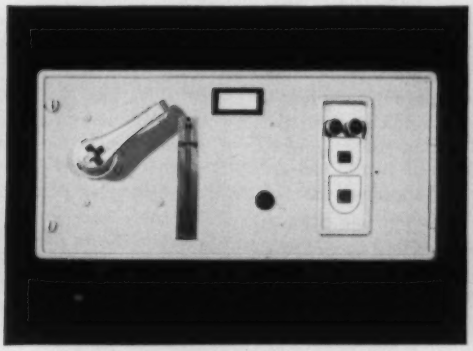
Fully interchangeable with the old design, this new control center is available for front mounting or back-to-back mounting . . . in same structure with common vertical bus. Everything about this new Westinghouse unit says good design, safety, and versatility. And you have the advantage of dealing with one source to supply all components. Call your Westinghouse sales engineer for all the facts. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. Ask for B-6722. J-21941

YOU CAN BE SURE... IF IT'S

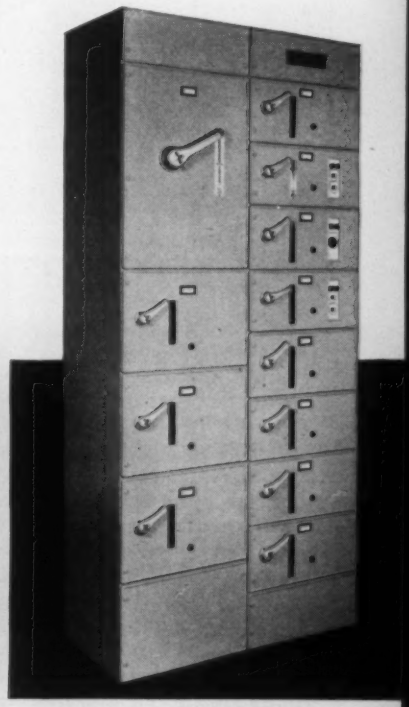
Westinghouse



Slight Movement of Retaining Clips . . . and horizontal starter unit support bar can be moved to any position for interchangeability of 9⅓- or 14-inch Westinghouse modular units.



Door Cutout makes it unnecessary to change door when changing pilot device arrangement. Quick-make, quick-break, positive-action, modern pushbuttons in strong molded case take up less space.



Here Is Complete Flexibility . . . of structural units and electrical components. Each vertical structure holds from one to eight, front only, or up to 16 back-to-back units, to meet all needs.

Circle 657 on Inquiry Card

Now--CONTROL offers you standardized saturable reactors

If you're a design engineer who would be delighted with industrial components which are sensitive and, under normal operation, last virtually forever with no maintenance or servicing, then you'll welcome CONTROL's *standard* lines of saturable reactors.

With CONTROL reactor assemblies and magnetic amplifiers, you know complete physical and operating characteristics —a copy of our Catalog R-10 awaits your request. And, delivery is fast because sub-assemblies of these units are stocked, awaiting your control-winding specifications.

CONTROL reactors are available for both 120- and 240-volt 60-cycle operation. There are eleven standard sizes in each voltage range. They have extremely high gain. Six ampere-turns control nearly 2,000 watts in the largest size. Power outputs range from 50 to 2000 watts, with only 2 ampere-turns required for control of the smallest units.

In addition to higher gain, smaller exciting current, and fewer ampere-turn characteristics, CONTROL reactors have a 40 to 1 cut-off ratio. They are totally enclosed so that the high performance toroidal cores used are protected, and the entire assembly has the ruggedness required for long life.

CONTROL offers the same convenience of standardization in use of high permeability magnetic devices that you've enjoyed with other components. Add to this convenience ruggedness and freedom from maintenance which is unmatched, and you'll welcome CONTROL to your design picture. Write for complete details and literature today. *CONTROL, Dept. A-36, Butler, Pennsylvania.*

Reliability begins with CONTROL

A DIVISION OF MAGNETICS, INC.

AUTOMATION news

Today's events and developments in the field of automation

Punched Tape Control System For Three-Axis Milling Machine

NUMERICALLY controlled milling system, to be applied to aircraft parts production, by the Martin Co., has been demonstrated and tested. The history of the machine reflects the increased complexity of machine tools manufactured for numerical control applications: Under an Air Force sponsored contract, and to Martin's specifications, the Research Laboratories Div. of Bendix Aviation Corp. undertook to develop a numerically controlled milling machine and system, including computing equipment. Bendix elected to build all electronic components and to subcontract the design and fabrication of the actual machine tool to the Kearney & Trecker Corp. The machine which was demonstrated is the first of 22 of a similar type being produced by Kearney & Trecker, and is a pioneer in that it was specifically designed for the numerical control system. Being specifically designed for the system enables the machine tool to exploit the advantages of numerical controls, since it is built rigidly enough to withstand the increased speeds and feeds which the control system is able to maintain.

FROM the console, one man can monitor the machining of parts on a milling machine equipped with numerical controls. Operator functions include installing the fixture and workpiece, loading and unloading the control tape, changing cutters, and starting and stopping the equipment. The machine, to be used by the Martin Co., consists of a control system developed by Research Laboratories Div., Bendix Aviation Corp. on a machine tool designed by Kearney & Trecker Corp.

DATA processing includes preparation of the punched tape as input to a computer which in turn prepares actual machine instructions on a punched plastic tape.

In use, the system requires the preparation of a completely planned process specification. Information on the process sheet, such as dimensions, feed rates, cutter radii, special instructions, etc. is transferred by Flexowriter operation to punched paper process tape. This tape serves as the input medium to a computer which calculates the actual machine instructions and punches the information into a plastic control tape.

As can be seen from the illustration, the machine is a horizontal spindle three-axis contour miller of the bed type. The working surface will accept a part 48 x 144 inches with no overhang. Longitudinal travel of the table is 120 inches, vertical spindle travel is 48 inches and traverse travel of head is 28 inches. Spindle is driven by a 20 hp motor and speeds vary from 36 to 1800 rpm. Feed rate varies from 0 to 50 inches with a rapid traverse of 120 inches per minute.

The machine can be used for mill-

ing high tensile steel as well as aluminum, and both the machine tool and the control manufacturers anticipate the use of the equipment in many metalworking industries. For instance, according to **Murray Kanes,** head of the electromechanical department at Bendix Research Laboratories, tape controlled machine tools could produce body dies for the automotive industry in about one-fourth the time required under present methods. Kanes also points out that the control system could be the answer to the cost problems of small and medium-size industries confronted with short and medium job lot manufacturing since such systems provide a means of economical changeover and low tooling investment. Instead of intricate and expensive tooling, the changeover from one job to the next can be handled almost as simply as replacing one reel of tape with another. It has been pointed out that the training of a process engineer to transcribe the necessary blueprint data into the form required for the system requires only a few days. Operation of the tape punching system and the computer also can be learned in a short period of time.

Transistor Market Survey Anticipates Tremendous Growth

PRODUCTION of transistors will increase almost four times in the next three years according to **William J. Peltz,** vice president and general manager of Philco's Lansdale Tube Co. Division. The forecast is based upon a market survey made for the Philco Corp. by the Stanford Research Institute.

Production of transistors for military, industrial, commercial and home entertainment uses is expected to reach 125 million units as compared with anticipated production of 26 million units for the current year. By 1958 production of both germanium and silicon transistors is expected to reach 59 million units.

The Stanford report, in which 80 companies in the electronic field co-operated, contained the following facts and estimates: In 1957, the military is expected to use 2 million silicon transistors, and in 1959, more than 18 million units. Military use of germanium transistors in 1957 is expected to be close to 5 million units and in 1959, almost 27 million units. In 1957, commercial and industrial use of silicon transistors is expected to be 250,000 units, and in 1959, more than 1 million units.

The report states, "Just how dramatically the transistor market will grow depends largely on price and success in building transistors that will meet increasingly stringent technical requirements . . . Sudden and unanticipated expansions are the rule rather than the exception; therefore, predictions for over-all growth and timing of such growth should be subjected to frequent checks."

FORMERLY chief engineer of Cargill Detroit Corp., **Avrel Mason** has been named general manager of a new division formed to handle engineering, manufacturing, and sales of automatic gaging and size controls. He is succeeded as chief engineer by **Belding H. McCurdy.** The new division of Cargill will permit intensive specialization on the various automation controls which have been developed by the company largely under his supervision.

Defense Department To Prepare Policies on Data Systems

IN RECOGNITION of the growing importance of electronic computers and automatic data processing systems to business management, Deputy Secretary of Defense **R. B. Robertson** has announced plans to develop common defense policies and joint programs in this area. To assist the deputy secretary, a Data Systems Policy Council has been established composed of senior policy representatives from each of the military departments and the offices of the Assistant Secretaries of Defense concerned. The council will give first attention to policies concerning the improvement of business systems through data processing devices, the selection of equipment, and the personnel aspects of electronic computer installations.

A Data Systems Research Staff has also been established in the office of the Assistant Secretary of Defense (Comptroller). This staff will provide the necessary research assistance to the policy council and the Assistant Secretaries of Defense. One of the duties of the staff is to assist the Comptroller in assuring the most prudent and effective expenditure of funds for electronic computer systems throughout the Department of Defense. The military departments emphasize that they will continue

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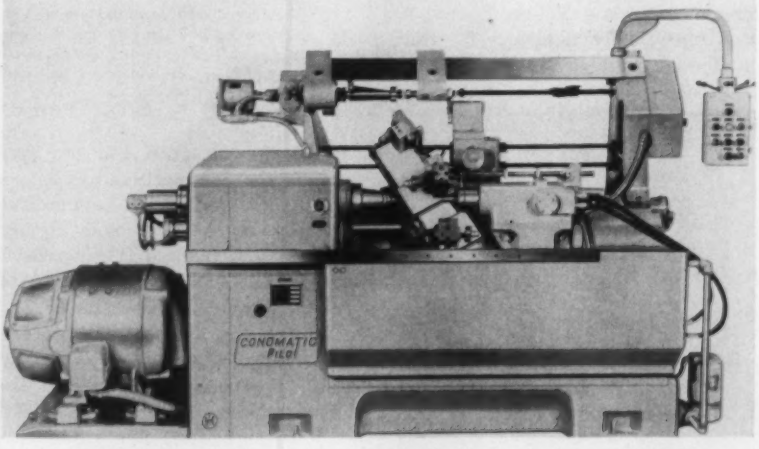

NEW DIVISION to handle engineering and sales for the Pilot automatic copying lathe has been formed by the Cone Automatic Machine Co. Inc. Developed by H.E.B. Machine Co., the Pilot lathe is noted as an extremely versatile automatic copying lathe. Cone Automatic has acquired United States and Canadian rights for the manufacture and sale of the machine. In operation, a system of hydraulic controls permits high speed production of profile-turned parts. Contours of the parts are determined by a stylus which moves over a rotating template. The lathe is multicycling and will take up to four repetitive cuts automatically.

A NEW AID FOR COST-CONSCIOUS MANAGEMENT

You can now determine just how much productivity you are losing because one or more elements of the operating cycle of an automated machine are not perfectly timed.

Now you can spot any timing error to within a 60th of a second immediately.

Cycle Analysis

Sheffield's new Monitorecord* system analyzes timing by means of a printed, composite time graph. This shows every start, dwell and stop of each interrelated event in the complex machine cycle – just as it occurs.

Corrective Adjustment

When a Coded Master is laid over the time graph you see just what adjustments are needed and the amount of each. No tedious groping – no costly down-time.

What could serve Preventive Maintenance more effectively than taking such a graph every day? What could save as much set-up time? This system often justifies its cost the first time it is used.

System installation is no problem. It can be applied to machines now in service or it may be built into new machines.

The readily portable Monitorecord is merely plugged into the system receptacle of any machine requiring cycle analysis. It can be moved about at will.

Get all the facts on this profit-conserving idea. Write to the *Sheffield Corporation, Dayton 1, Ohio, U.S.A., Dept. 3.*

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their present comprehensive efforts to utilize the most modern data processing systems within the framework of overall Department of Defense policies.

ACQUISITION of the stock of Davies Laboratories Inc., Beltsville, Md., by Minneapolis - Honeywell Regulator Co. has been announced. Davies Laboratories has been active in the design and manufacture of complete systems for airborne magnetic tape data recording and ground playback and data analysis.

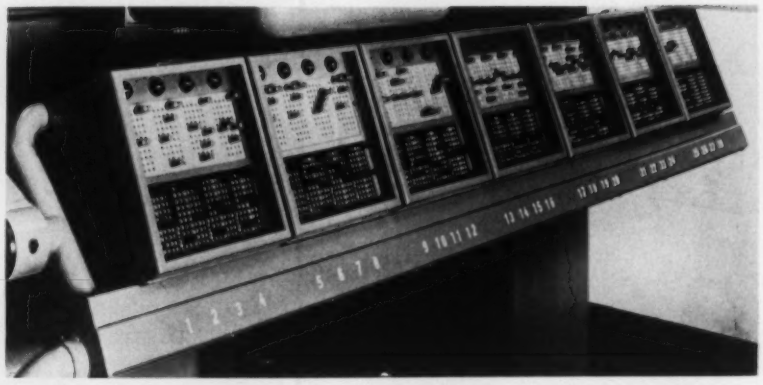
Plant-Wide Intercom System Serves Central Record Office

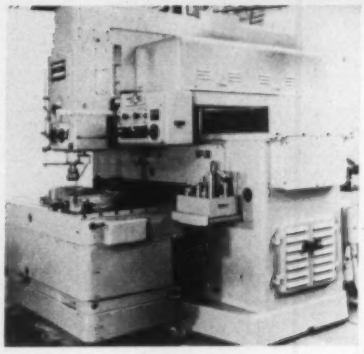
FASTER FLOW of information is possible with a call box and central office timekeeping system used in the Metallurgical Products Dept. plant of the General Electric Co. As a production worker reports to his department he uses a call box at his work station to report his presence, clock, job and operation number. This information is received at a central office and immediately key punched into a tabulating card. Later, when the worker finishes his first job, he again uses the call box to report what he has accomplished, including details of a new job he is about to tackle. This procedure is repeated every time a work change occurs during the day.

According to **L. R. Butler,** manager of payroll and timekeeping, who developed the setup, the system already has paid for itself three times over, making an annual saving of about $36,000. Its immediate effect was to release 11 badly needed workers for other duties, and to eliminate travel and waiting time required under the previous timekeeping method in which workers reported to timekeepers stationed throughout the plant.

In the central office, three master control boards make it possible for any call originating in the plant to be handled. Variable data received in the central office is key punched into tabulating cards which are integrated with master cards. The latter contain prepunched rates and job information for accounting purposes.

P. J. Jensen, manager of manufacturing, reports that, "the system not only helped us find additional manpower within the company for productive work, but eventually, it will pin-point those production variables which crop up to hinder a production worker from turning out a creditable day's work."





AUTOMATIC spindle positioning is possible on boring and milling machine manufactured by Schwartzkopff Berlin. Marac Machinery Corp., Yonkers, N.Y. is responsible for sales and service of the machine in America. The basic machine can be converted for program control by the use of the illustrated plug board attachment. The device permits advance setting of center distances and milling traverses while the machine is being loaded. Up to 28 co-ordinates can be programed in advance. Four program points can be set on the plug board in each of the seven control boxes in any desired sequence.

Second Automation Conference To Meet At Purdue University

SECOND Conference on Manufacturing Automation is presently in the final planning stage. The Purdue University-AUTOMATION cosponsored conference is scheduled for Oct. 7, 8 and 9 at Purdue University, and as further details of the conference are made available, they will be covered in subsequent issues of AUTOMATION.

Based upon a consensus of answers to a questionnaire circulated to those in industry who attended the First Conference, the Second Conference program will concentrate on the following areas: economics, measurement, control, mechanical handling, and assembly.

A feature of the conference program will be the amount of time devoted to round table discussions, the afternoons of the 8th and 9th of October being reserved for this purpose. Discussion leaders will be drawn from a wide variety of industries. The opportunity for more active participation in discussion sessions by all conference members will ensure that the Second Conference on Manufacturing Automation fulfills its purpose: to develop practical and authoritative information to aid responsible individuals in industry in adopting more automatic operations.

FORMATION of a contract engineering department has been announced by Beckman Instruments Inc. through its Helipot Division. The new department will specialize in the design and production of electromechanical subsystems for aircraft, guided missiles and industrial plant control equipment under supervision of Technical Director **O. C. Bixler. Frederick March,** formerly chief customer engineer for Helipot, will manage the new department. He was previously

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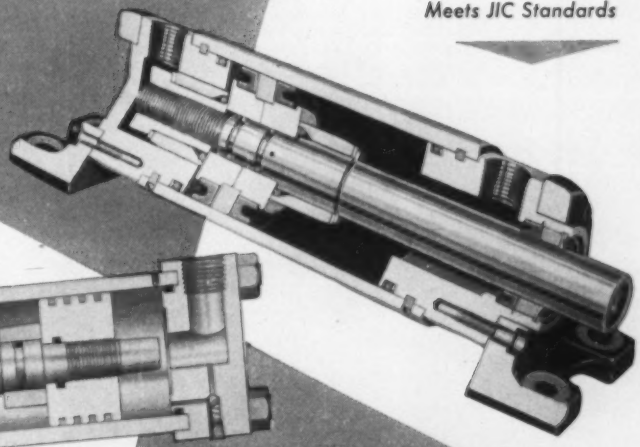

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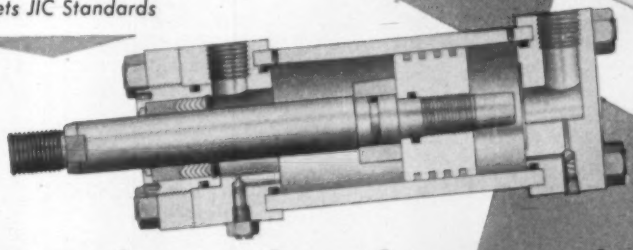

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- Smooth, dependable operation at all practical speeds.
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- Machined bearing bronze bushings for maximum service with minimum friction.
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- Adjusting needle for cushion control with ball checks for rapid full power starts.
- Versatile port orientation.
- Wide range of mounts and mounting accessories.
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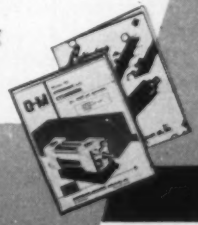
- Plus many other features.



O-M Air and Hydraulic Cylinders are available in 1½" to 8" bores with standard and heavy-duty piston rods.

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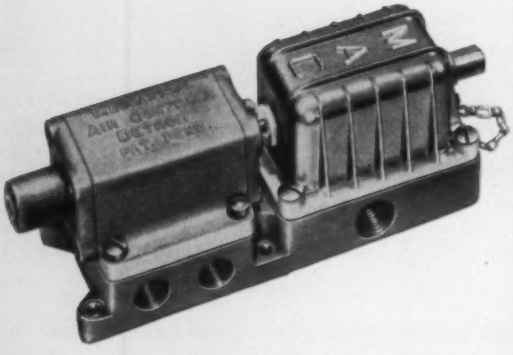

Take the pearl! It develops, layer by layer, until it attains rare beauty and value.

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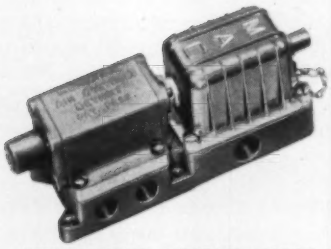

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employed by General Electric in the development of radar, automatic pilot and aerial fire control systems.

Process Instrument Designs Available for Manufacture

AVAILABILITY for licensing of certain patents which cover three instruments for automatically measuring streams of gases and liquids in production processes has been announced by the Carbide & Carbon Chemicals Co., a division of Union Carbide & Carbon Corp. The instruments are a chromatographic analyzer, a differential refractometer and an electrolytic concentration cell. The company is now using them in its own plants and will license instrument makers to produce and sell them to industry. In making the announcement, **D. B. Benedict,** president of Carbide & Carbon Chemicals Co., said ". . . Our instruments make it possible to analyze streams continuously, so that quantitative changes in constituents are immediately recorded and controlled. Process operation and quality of product will be greatly improved by these instruments which represent additional forward steps in the direction of process automation."

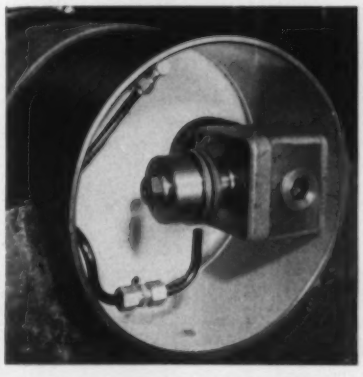
The chromatographic analyzer can analyze for one or more components of many mixed gas streams by passing a sample of the mixture through a packed tube. In the tube the components are separated and the percentage of each gas in the mixture is registered automatically. The differential refractometer provides a continuous analysis of liquid streams by comparing the index refraction of the liquid to a liquid of known index. Electrolytic concentration cell measures the difference between the ionic concentration of two liquids. This cell is useful in measuring trace amounts of certain gases in plant streams.

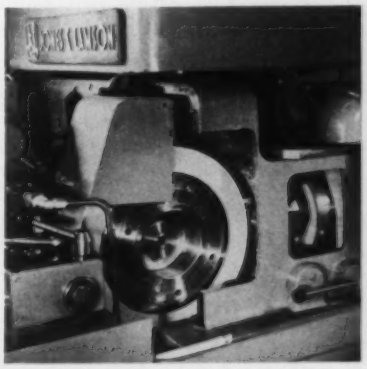
High Taxes Retard Expansion

AT the annual convention of the National Screw Machine Products Association, the problem of tax relief came under discussion. A resolution passed overwhelmingly by the members, requested that sufficient tax relief be granted to enable the

---

COMPLETE automation of production grinders is possible with a newly developed process that provides for continuous dressing of wheels. Developed by Jones & Lamson Machine Co. and Koebel Diamond Tool Co., the process combines two advancements: (1) perpetual form control of grinding wheels and (2) form cutters which use cemented diamond particles in a powder-metal cutter body. The form control equipment consists essentially of attachments to existing machine designs. The cutter which maintains the wheel form acts much like a milling cutter, and is motor driven in contact with the wheel at a speed somewhat higher





than the wheel. A differential feed arrangement advances the grinding wheel and cutter in the exact increments called for by removal of grinding wheel stock by the cutter, so that correct work size is automatically maintained during the life of the wheel. As preselected, the cutters can operate in either intermittent or continuous contact with the wheel while it is cutting. The detailed picture shows a simple Koebel cutter mounted in a feed cylinder. The entire cylinder feeds forward, keeping the cutter in contact with the wheel. As shown, coolant is supplied to maintain optimum cutter life.

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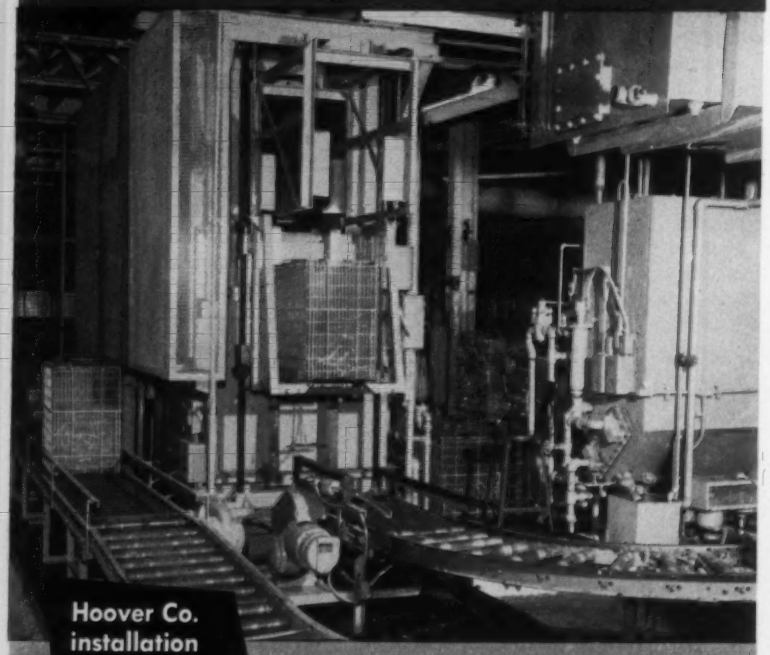

Hoover Co. installation pays for itself in 10 months

Gravity-roller conveyors move work to and from cleaning chambers. Hydraulically-powered elevator and indexing equipment moves work into and through cleaning chambers.

The automated solvent degreasing installation at The Hoover Company, North Canton, Ohio, clearly demonstrates the advantages of DETREX-designed metal cleaning and processing equipment.

- Reduces "down-time" for maintenance by eliminating chains and sprockets inside the cleaning chamber.
- Requires less floor space and ceiling height because of compactness of conveyor system.
- Provides more uniform uninterrupted cleaning cycles for a greater variety of parts.
- Reduces solvent consumption through increased over-all efficiency of automatic installation.
- Eliminates manual loading and unloading of degreaser and reduction in necessary supervision.

Check the advancements provided by DETREX automation. You'll see why DETREX, pioneer in metal cleaning and processing, is the leader in the field. DETREX can recommend and engineer the right combination of chemicals, equipment and services to fill your specific requirements. Write today for detailed information.

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association members to retain a needed portion of earnings to replace capital equipment and to expand the industry.

According to **Dana B. Jefferson, Jr.**, president-elect of the association, "Our profit has decreased alarmingly during the past two decades. Profits per dollar of sales were 54 per cent lower in 1955 than in 1937. Federal taxes rose from 16.7 per cent of gross profit in 1937 to 48.7 per cent in 1955. During the period 1947 to 1955, profit per sales dollar has dropped 35 per cent. This has been due to an increase in taxes of 55 per cent, an increase in labor rates of 62 per cent, plus rising costs of equipment and materials of 75 and 85 per cent respectively. Price rises during this same period have amounted only to 45 per cent."

In terms of replacement of capital equipment these figures mean that a company with average profits and sales of $1 million a year, would have net earnings of only $39,000, plus a tax depreciation credit of about $11,000. Even if it used all its profits and tax credit for new equipment, it would still have only $50,000 to do the job. And to purchase only one complete multiple spindle screw machine, an expenditure of $25,000 would be required.

Dial Radiotelephone System

SYSTEM which allows phone calls to and from vehicles to be relayed, completely unattended, through local telephone systems, is available from Allen B. Du Mont Laboratories Inc. Unlike other radiotelephone systems, it operates on a 24-hour basis without requiring manual operators. Calls are made from a vehicle by simply dialing a number within a local telephone system, and anyone within the system can call the vehicle in the same manner as when making a house to house call. Only when placing a toll call must the long distance operator be contacted.

The system was designed by **Ramsey McDonald** of Richmond Radiotelephone Inc. and consists of a dial radio-telephone in a vehicle, employing a two-way radio system as a carrier to the local telephone company installation; and a trans-

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418	448	478	508	538	568	598	628	658	688	718	748	778	808
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421	451	481	511	541	571	601	631	661	691	721	751	781	811
422	452	482	512	542	572	602	632	662	692	722	752	782	812
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424	454	484	514	544	574	604	634	664	694	724	754	784	814
425	455	485	515	545	575	605	635	665	695	725	755	785	815
426	456	486	516	546	576	606	636	666	696	726	756	786	816
427	457	487	517	547	577	607	637	667	697	727	757	787	817
428	458	488	518	548	578	608	638	668	698	728	758	788	818
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Reader's Service Dept.

mitter-receiver base station which is interconnected with the local telephone system. Termination and switching equipment at the base station automatically transfers the radio calls to the telephone system and telephone calls to the radio system. Only two telephone lines are required to interconnect the base station equipment with the telephone company's central office.

BOARD of directors of Vickers Inc. has appointed **J. F. Forster** executive vice president. He will have direct charge of all Vickers' operations, according to an announcement by **K. R. Herman,** president. Vickers Inc. is a major manufacturer of oil hydraulic equipment which is used on aircraft, machine tools, agricultural and construction machinery, motor vehicles, etc. Forster joined the Vickers organization as treasurer in 1941 and was made vice president and assistant general manager in 1949. He came to Vickers from Sperry Gyroscope Co. where he was production planning manager.

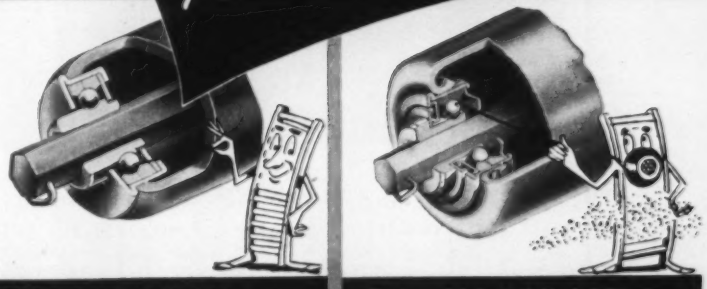
Reliable Emergency Lighting

CENTRALIZED emergency lighting system that constantly supervises itself has been designed by the Standard Electric Time Co. The equipment is designed to equal the reliability of self-monitoring fire alarm and sprinkler systems widely used in industry.

The emergency lighting system reports, by flashing lights and buzzers, any fault in the system and sounds an alarm when an emergency lamp is removed from its socket. The built-in supervision makes the system 100 per cent foolproof and gives full assurance that emergency light will be available whenever regular power fails. Power is supplied by a special 32-volt battery which is automatically recharged and kept at full capacity by a constant trickle of charging current. Reliability of the system is assured by the use of a battery that is good for 25 years or more service. As a feature of the system, the battery is contained in a control console located in a room

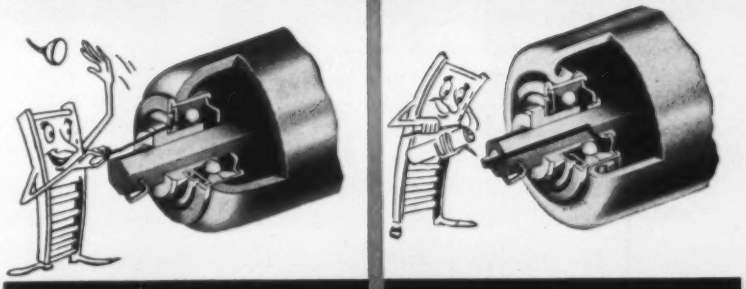
Better Built

BUSCHMAN ROLLER CONVEYORS Feature:



Plain Ball Non-Lubricated Bearings

Dustproof Labyrinth-Sealed Bearings



Grease-Packed-For-Life Bearings

or Pressure Lubricated Bearings

TO MEET YOUR REQUIREMENTS

In roller conveyors, it's the bearing that counts! And BUSCHMAN conveyors use only performance-proven bearings... engineered for long life and trouble-free operation in every type of service. No matter what normal operating conditions may be, BUSCHMAN has a conveyor pre-engineered to meet your needs.

Conveyors are available with various types of rollers and frames, in different sizes and spacings, and in any width from 6 inches on up. BUSCHMAN can supply 45° and 90° curved sections, switches, spurs, work stations and other components to provide a complete, efficient materials handling system.

For Complete Details, Write For 16-page Catalog No. 60 Today.

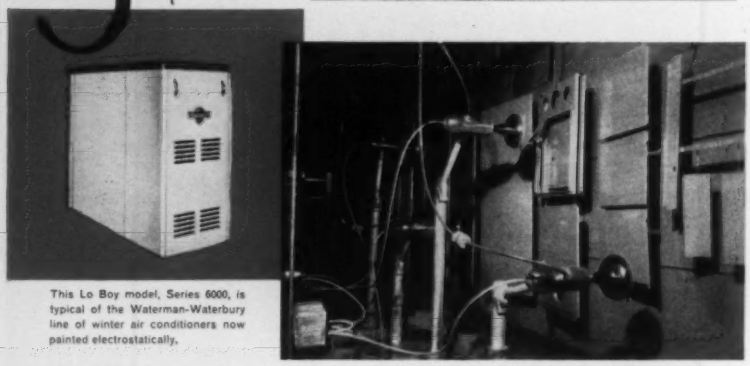
PRODUCE MORE ... FOR LESS on Buschman Conveyors

C-113-EWB

THE E. W. BUSCHMAN COMPANY
4551 Clifton Ave. • Cincinnati 32, Ohio

Circle 663 on Inquiry Card

3 times as many Furnace Casings per gallon of paint with **RANSBURG NO. 2 PROCESS!**



This Lo Boy model, Series 6000, is typical of the Waterman-Waterbury line of winter air conditioners now painted electrostatically.

Quality of work is improved; Labor costs are cut and Production Stepped up 150% with

RANSBURG Electrostatic Spray Painting

Results exceeded expectations when Waterman-Waterbury, Minneapolis, modernized their finishing department and went from hand spray to Ransburg No. 2 Process in painting their quality line of heating and air conditioning equipment.

By the former hand spray method, W-W used a half gallon of paint to coat a single casing. Now, with Ransburg No. 2, they get SIX CASINGS PER GALLON . . . or 3 times as many per gallon. Furnace casings, as well as other painted parts which go into the famous Waterbury Furnaces, now get a uniform coating of .8-mil.

Production was increased, too, as automatic painting enabled them to step up the conveyor speed from 7 fpm to 11½ fpm. Where they formerly turned out a complete furnace in five minutes, NOW they assemble three in just six minutes . . . an increase of 150%. All in all, they figure the modernization program—with Electro-Coating—saved over $11,000 in the first three months of operation.

NO REASON WHY YOU CAN'T DO IT TOO!

Whatever you paint, we'd like to tell you more about the efficiencies and worthwhile savings which can be yours with Ransburg Electro-Coating Processes. Get our No. 2 Process brochure which cites many on-the-job examples of electrostatic spray painting on a wide variety of products. Or, we'll be happy to loan you our new film, "The Big Attraction" which tells the electrostatic spray painting story in sound and full color.

Call or write

RANSBURG
Electro-Coating Corp.
Barth and Sanders, Indianapolis 7, Indiana

away from areas of potential danger from fire, explosion or flooding.

NEWLY appointed engineer for the Special Machinery Div. of the Teller Co. is **Charles L. Zoltani.** The Special Machinery Div. is concerned with industrial automation and plant mechanizations, and its work ranges from design and redesign of production line machinery through manufacture of bulk chemical and pharmaceutical processing equipment. Zoltani previously served with the H. H. Robertson Co. as a project engineer and with Babcock & Wilcox Co. as a development engineer.

SEMICONDUCTOR insertion equipment designed by Hughes Aircraft Co. is expected to expand the use of semiconductors in industry. The company invented a machine that fabricates the flexible belts used to hold precisely space semiconductors and adapted the illustrated stapling machine manufactured by United Shoe Machinery Corp. to tack the items into place at the assembly point. Hughes reports that they make about 20 per cent of semiconductors produced, and will supply the belted semiconductors at no increase in price.

Mutual Inductance Probe For Rotor Position Indication

CONTINUOUS measurement of the clearance between the rotating and stationary blades inside a steam turbine is possible with an electronic instrument that has been developed by the National Bureau of Standards. The detecting element of the system is a mutual-inductance micrometer probe in printed circuit form on a ceramic base that resists high temperature

Circle 664 on Inquiry Card

New from Clary!

"Guided" valves for guided missiles!

high-pressure line valves with 5 choices of actuation!

Now you can "guide" the operation of these valves with 5 different actuation systems – solenoid, pneumatic-hydraulic, manual, explosive or shuttle! A truly complete line of high-pressure line valves.

Here at Clary, our years of experience in manufacturing guided missile components – gyroscopes, servo-actuators, propellant valves, telemetering transducers – now enable us to bring you these high-pressure line valves built with the same precision. Our extensive inspection and quality control guarantee the maximum reliability required of missile components.

When **precision, reliability** and **versatility** are factors in your plans, please call on Clary for complete services, including:

DESIGNING AND TESTING to established specifications and envelope drawings.

PRODUCTION-ENGINEERING of components and complete assemblies covered by your prototype, sketches or drawings.

MANUFACTURING of precision components to established drawings and specifications.

(Shown from top to bottom)

SOLENOID
Hermetically sealed coil
18-30 volts D.C.
Low current consumption

PNEUMATIC-HYDRAULIC
3000 psi operating pressure
Zero leakage
"O" ring seals

MANUAL
Miniaturized toggle action
On-off control
Fixed flow

EXPLOSIVE
Positive on-off action
Trigger release
Protected seat

SHUTTLE
Repetitive reliability
Ideal for final check-out system
Non-interflow

Clary

AUTOMATIC CONTROLS DIVISION

Clary Corporation, Dept. K67, San Gabriel, California

MANUFACTURER OF BUSINESS MACHINES, ELECTRONIC DATA-HANDLING EQUIPMENT, AIRCRAFT AND MISSILE COMPONENTS

Circle 665 on Inquiry Card

ARTER JIGMATIC WILL DO *all* YOUR POSITIONING AND *do it fast*

ARTER

TAPE-CONTROLLED AUTOMATIC POSITIONING TABLE

Check These Features...

- No stops
- No gauge rods
- Only SECONDS to change tapes
- MINUTES to set up
- No more than 11 tape holes to punch per position
- 600,000,000 possible positions. Hundreds of positions per single set-up
- Automatic magnetic locking
- Accuracy — plus or minus .001"
- Unidirectional approach at minimum speed
- Simultaneous operation of both coordinates

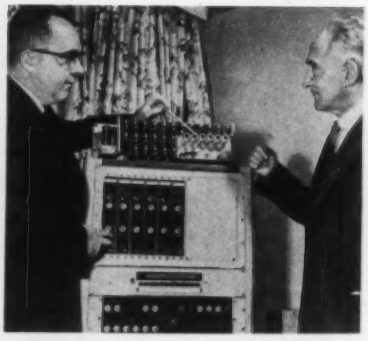
The 20"x30" ARTER has them all

ARTER GRINDING MACHINE COMPANY

WORCESTER 5, MASSACHUSETTS

Jigmatic Automatic Tape Controlled Positioning Table • Rotary Surface Grinders
Flat Circular Cutter Grinders • Internal Grinders • Cylindrical Grinders • Carbide Tool Grinders

AGENTS IN INDUSTRIAL CENTERS OF UNITED STATES AND CANADA



SUPERVISORY control system that will permit more than 1000 different codes to be transmitted over a single two-way channel has been introduced by Hupp Electronics Co., a division of Hupp Corp. System is particularly suited for the control of pipe lines, power stations, railroad switches and similar applications where operators at one or more locations are needed to control equipment at distant points and where it is important to get positive identification that each job is accomplished in accordance with a control signal. The remote switching units operate on any communication facility acceptable to standard teletype transmission. Equipment required at either a control or remote point includes a transceiver, sequence and alarm circuits, power supply, one function module for each On-Off function to be controlled and a 12-pushbutton panel for controlling single-state functions, such as ringing a bell at a remote point.

steam erosion inside the turbine. The indicator permits accurate determination of blade clearance by measuring the axial distance from the shrouding around the rotor blade tips to the base of the outer stator blades.

A typical mutual inductance probe contains two coplanar, coaxial coils wound on a dielectric core. A radio frequency source that is regulated with respect to the product of the frequency and current energizes the primary coil. The ac voltage induced in the secondary coil depends on the distance from the probe to a nearby electrically conducting reference plate. Suitable electronic circuits then detect and amplify the output voltage from the secondary coil, and the amplified voltage is indicated on a meter calibrated to give the probe-to-surface measurement in inches or centimeters. The instrument can detect very rapid displacement changes, and aids in studying problems in steam turbine operation where transient thermal conditions

another VALVAIR *first...*

NEW SPEED KING PLUG-IN CONTROL VALVES

Compare
... and you'll
buy

Valvair

RESEARCH...
PROGRESS...
LEADERSHIP...

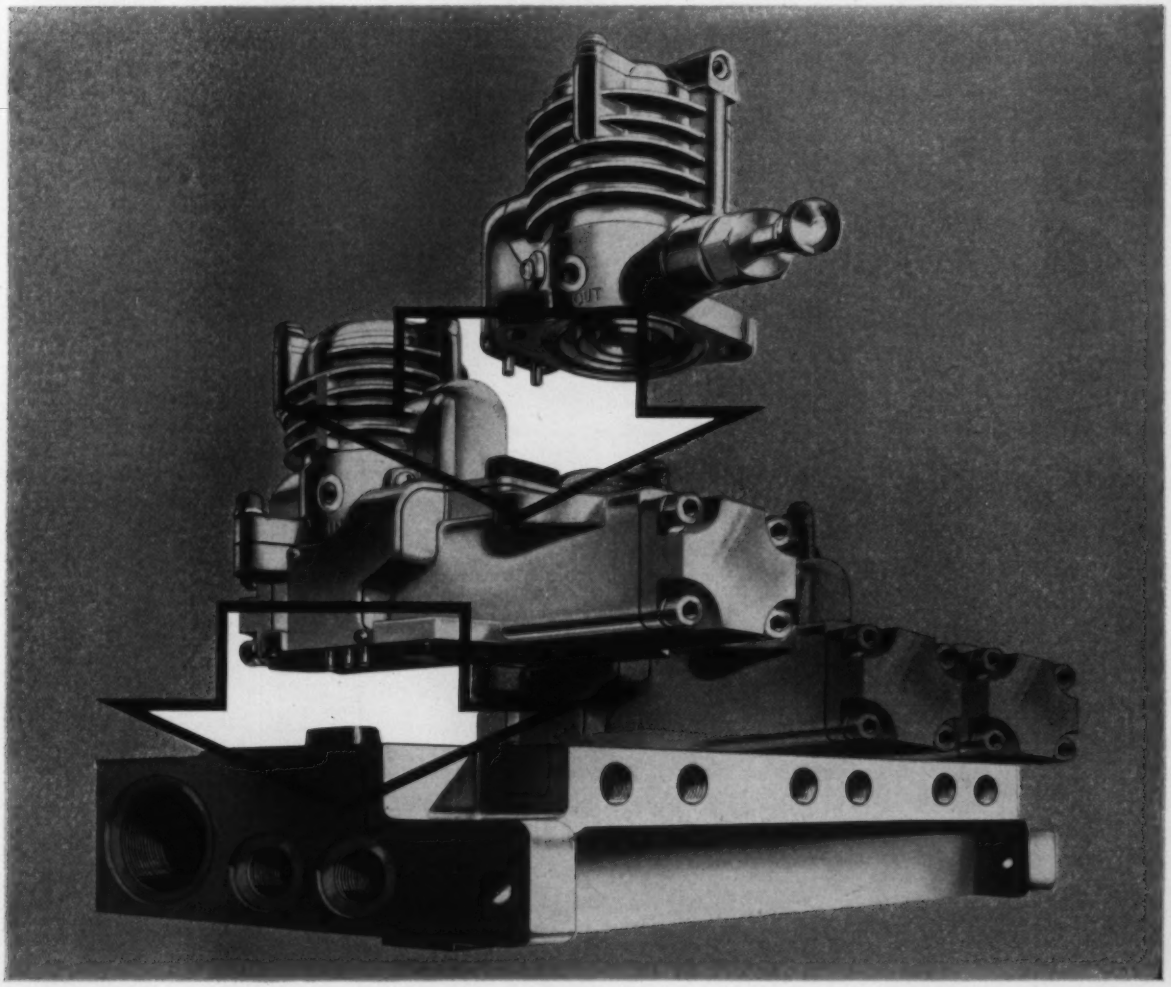
Representatives in principal cities

Valvair's new Speed King ¼ in., 4-way control valves have built-in plugs and connectors—complete electrical connections automatically! All connections are made in manifold or sub-base—valves simply bolt in place. Pilots plug in, too, for fastest in-service maintenance!

And, compact size, peak performance plus multi-million cycle dependability, assured by aluminum and stainless steel components . . . coil guaranteed against burn-out for life of valve . . . manifold, sub-base or foot mounting—single or double solenoid . . . JIC pilots . . . 35—200 psi range . . . ¼ in. NPT ports . . . coils for ac or dc, any voltage . . . optional manual over-ride . . . all are yours with ¼ in. Speed Kings!

Put these advanced-design valves to work on your machines . . . their performance and economy will amaze you! Valvair Corporation, 454 Morgan Ave., Akron, Ohio. AA-5593

Multiple manifold mounting; 3 station shown, 2 station available. Conduit port, 1¼ in. NPT; common inlet and exhaust ports, ½ in. NPT; cylinder ports, ¼ in. NPT. Manifolds may be ganged for installation of any number of valves. Sub-base and foot-mounted valves also offered.



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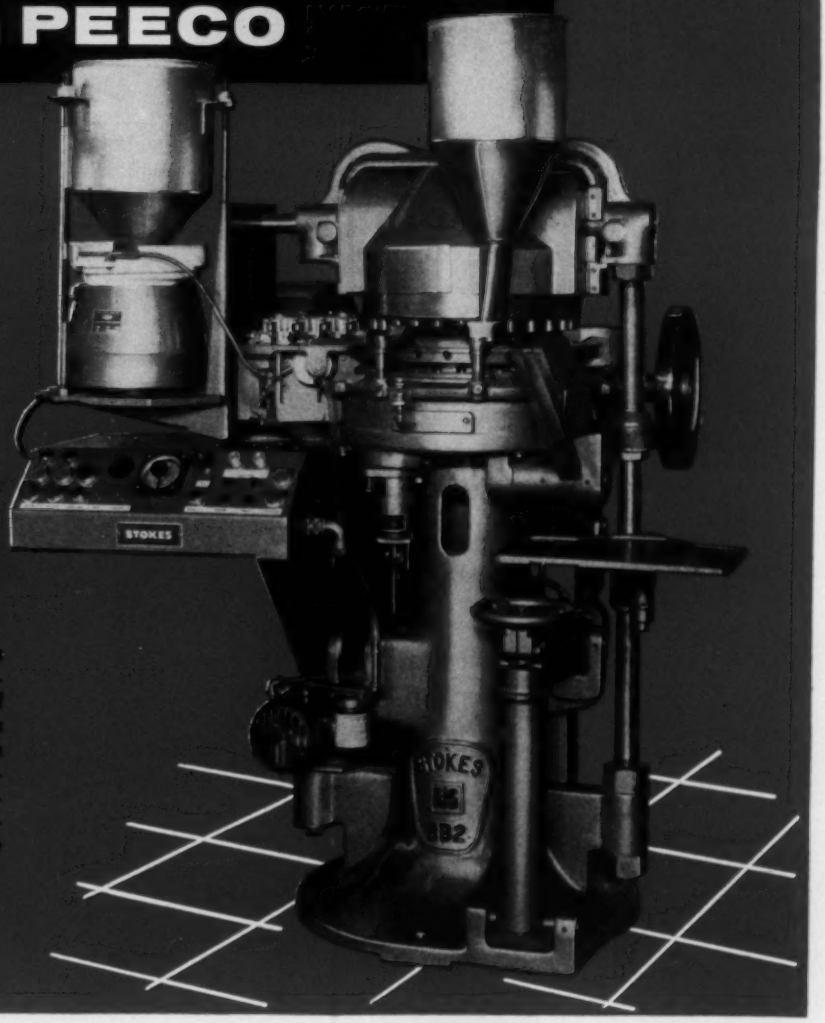
production equipment produces MORE with PEECO



STOKES

NOW developed PEECO feeders are included on STOKES pharmaceutical equipment. The Model 538 Mark II (illustrated) produces press coated tablets with a high degree of uniformity and precision at rates up to 750 per minute. Tablet cores are fully oriented, without dusting within the PEECO feeder bowl.

PEECO'S leadership in the field of vibratory parts feeders has contributed much in helping increase the capacities of new production equipment in various markets. We are glad to include among the companies now being served by PEECO, F. J. Stokes Corporation of Philadelphia, Pennsylvania, manufacturers of pharmaceutical equipment for two-thirds of a century.

If you want to produce more, send for bulletin No. 365 and ask for the name of the PEECO representative in your area.

THE WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF VIBRATORY PARTS FEEDERS

Peeco PERRY EQUIPMENT & ENGINEERING CO.

ERIE, PA. • • • DIVISION OF AUTOMATION DEVICES, INC.

Circle 668 on Inquiry Card

can cause large differential expansion between rotor and stator blade assemblies.

Human Engineering Important To Automated Industry

HUMAN engineering specialists at Battelle Memorial Institute anticipate that their field may become a more important part of the industrial scene as automation increases. Because automation places large quantities of production capacity under the control of one operator, operator error must be minimized. This is one of the major functions of human engineering.

Dr. Richard S. Laymon and **Charlotte A. Christner** of the Battelle Institute, in a recent issue of the Battelle Technical Review, note three ways in which human engineering might play a part in the development of automation. First, human engineering can be employed to produce machine designs that minimize the probability of human errors. Second, it can provide recommendations as to which production tasks should be allocated to machines and which to humans, making the decision on the basis of which type of producer can perform a task with the fewest errors. Third, since repair time is more expensive on the larger, automated production lines, and since, as a rule, these lines cannot be replaced by people or duplicate machinery while they are being repaired, human engineering may be used to decrease service and repair time by designing the equipment with the human engineering requirements for maintenance in mind. Among these maintenance requirements are accessibility and identification of parts, and the capabilities and limitations of the men who will do the maintenance.

Pneumatic Handling Device

MATERIAL handling device which is useful for movement of bulky but fragile products is marketed by the Presray Corp., a division of Pawling Rubber Corp. The device has proved to be especially valuable to abrasive wheel manufacturers. Movement between forming presses and kiln trucks of

SEMINAR devoted to the understanding of automation and material handling has been presented by the St. Louis chapter of the American Material Handling Society. In the picture, a copy of a program serves as a focal point for the principals connected with the seminar: (standing) A. F. Sperry, president, Panellit Inc.; R. M. Muther, executive director, Richard Muther & Associates; M. M. Arlin, president, Arlin Products Co.; E. A. Carlson, president, St. Louis chapter, AMHS; (seated) R. A. Surveyer, Alton Box Board Co., general chairman of the seminar; and R. W. Bolz, editor, *AUTOMATION*. J. R. Bright, Harvard Business School, who spoke along with Bolz, Arlin, Muther and Sperry, is not shown.

CHILE	COLOMBIA	PERU	ARGENTINA
SPAIN	PORTUGAL	SO. AFRICA	SWEDEN
ISRAEL	JAPAN	BELGIUM	MEXICO
INDIA	AUSTRIA	BRAZIL	CANADA
ITALY	GERMANY	URUGUAY	ENGLAND
DENMARK	FINLAND	FRANCE	U. S. A.

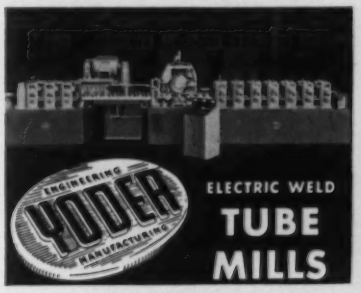
24 NATIONS UNITED...
on Choice of Yoder Mills for Pipe and Tube Manufacture

It all started less than two decades ago with the introduction by Yoder—and the rapid adoption by American industry—of a revolutionary new type of mills for cold forming and electric-resistance welding of pipe and tubing. England, France, Italy, Mexico, Argentina, and Brazil soon followed the U.S.A. in adopting these mills. Other countries boasting any kind of modern metal working industry did likewise, even including distant Japan, India and South Africa. Production, depending on requirements, varies from 25,000 up to 75,000 feet per 8-hour shift.

By this time, England, Italy and Argentina each have a total of ten Yoder mills in operation; Brazil, eight; Mexico, six; France, five; other nations somewhat in proportion to their population. In many nations, Yoder mills now supply from 50% to 90% of all welded tubes used. Several oustanding production records have been scored by operators in foreign countries, most recently in Italy. Reasons: the simplicity of design, ease of operation and dependability of Yoder mills. Secondly, generous assistance rendered by Yoder in training operators everywhere.

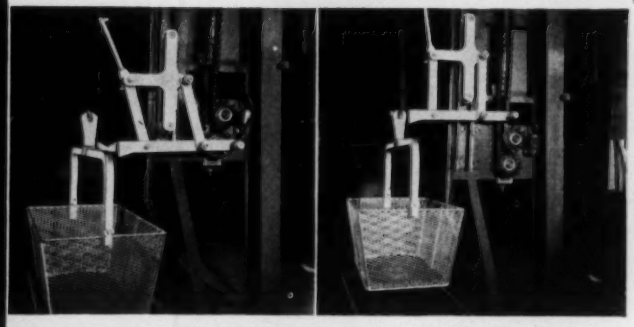
Through technological advances, Yoder leadership in tube mill design has been jealously maintained and strengthened from year to year. Ask for literature giving details of the latest improvements. Correspondence invited.

THE YODER COMPANY
5526 Walworth Ave. • Cleveland 2, Ohio, U.S.A.



Circle 669 on Inquiry Card

New TRANS-FREE Automatic



1 Pick up made at table near floor level, basket is loaded with parts on which intermediate work has been done.

2 Elevator arm engages crescent hook and starts basket up. Chain-drive lift is independant of overhead free-line.

Allied Conveyor System Uses Just Six Feet of Floor Space For Every Elevator Required

A recent Trans-Free installation shown here services an entire manufacturing department, yet its five work station elevators occupy a mere 30 square feet of floor space. All the rest of the completely automatic system—tracks, trolleys, load bars—is high overhead, out of the way of the work area.

With the new Trans-Free system, conveyor rail stays intact... no lowering of the track... *only the load* is transferred by elevator to floor level. Using standard track and trolley Trans-Free can be economically integrated with existing facilities.

With Trans-Free you can load to, from, and at any predetermined selection of work stations. Load timing, transfer, circulating storage, load control, dispatching and selection, all are automatic. Trans-Free gives you truly automated work handling, lowered labor costs, and is basically mechanical—so maintenance is at a minimum.

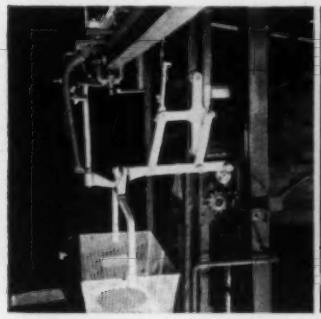
If you would like complete information on Trans-Free, simply write Allied Conveyors, or better still, next time you're in Detroit, drop in and see this unique system in actual operation. The phone number is TWinbrook 2-3040.

◀ Processed work goes up — to conveyor system 20 feet overhead.

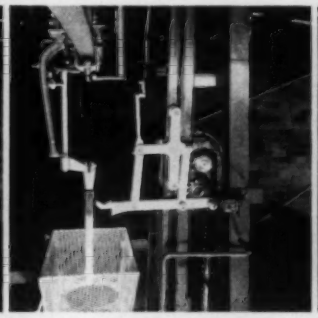
ALLIED

Installation Provides

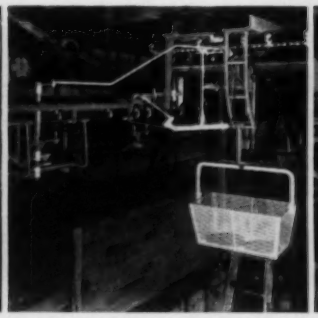
Product Handling 20 Feet Overhead



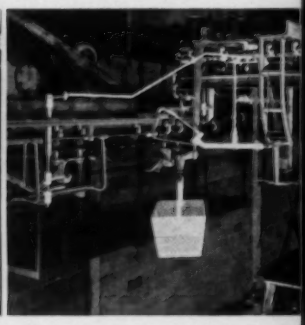
3 Out of the way 20 feet overhead, the basket is transferred to free line. Alignment devices assure positive transfer.



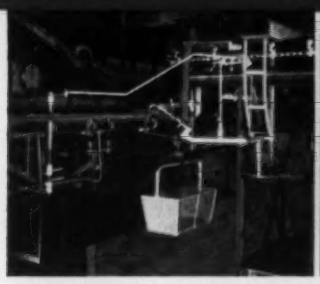
4 Elevator hook has been disengaged and free trolley takes the load and starts it toward the main conveyor line.



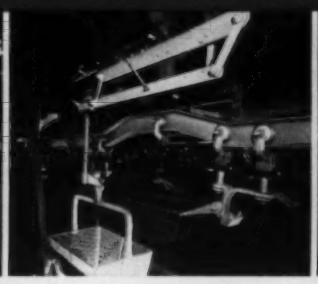
5 As load nears main conveyor it is synchronized by means of mechanical linkage to intercept an empty load bar.



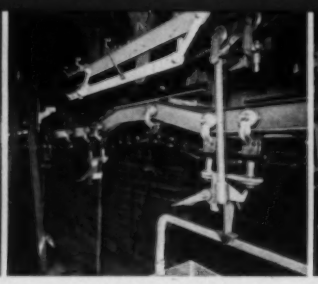
6 The basket approaches in a position parallel to the main conveyor line. Incoming and outgoing loads cannot collide.



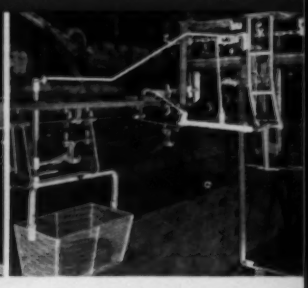
7 Travelling parallel to main line, basket is nearing transfer point. Synchronization coordinates the two lines.



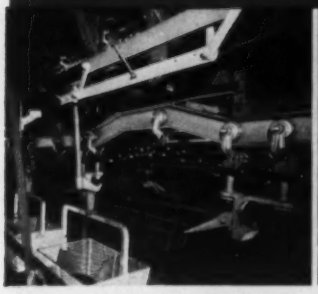
8 Load on free trolley is ready for mechanical transfer without use of air cylinders, solenoid switches, etc.



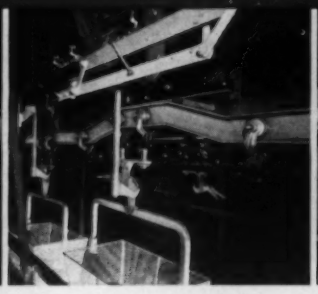
9 Transfer to the main line is completed mechanically when load bar takes the basket from the free trolley.



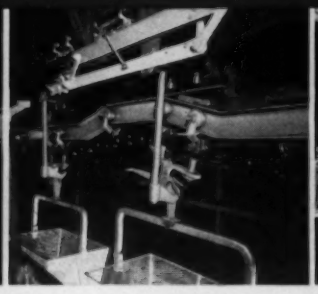
10 In the reverse operation, loads dispatched for transfer at this point are selected from the main line.



11 Here, in a reverse transfer from the main line back to the free, the load bar is about to engage the free trolley.



12 At the incline of the main line, the load bar and the free trolley have not yet made contact for transfer to free trolley.



13 As main line dips, basket is positively and mechanically shifted from load bar to free trolley with complete safety.

14 Loads now travel along free line to elevator pick-up and await transfer to work area at floor level 20 feet below.

ALLIED CONVEYORS

ALLIED STEEL & CONVEYORS • DIVISION OF SPARTON CORPORATION

17367 HEALEY AVENUE • DETROIT 12, MICHIGAN • CABLE ADDRESS: ALCON

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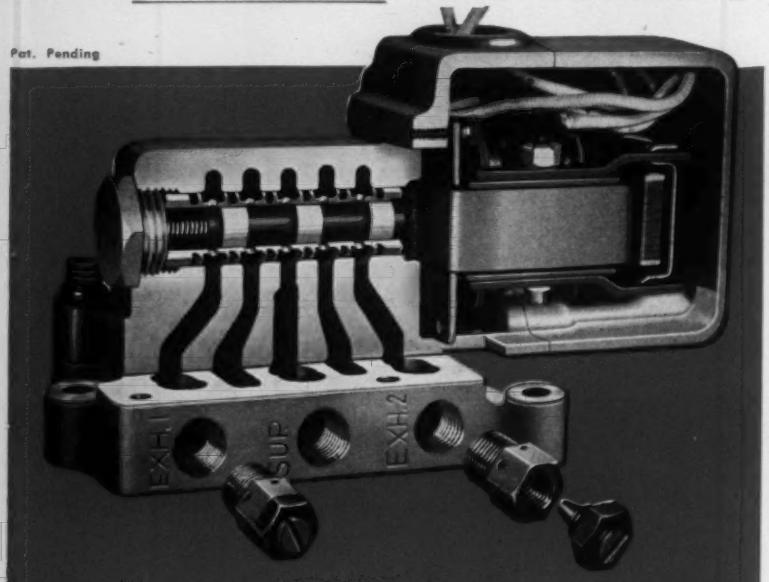
now . . . AIR VALVES

WITH EXTREMELY FAST RESPONSE

Pat. Pending



. . . Almost TWICE As Fast As Ordinary Valves!

The new SA Series single solenoid actuated valves are available in both single and dual pressure models with extremely fast response time. You get total response in 12 *milliseconds*—from energizing to wide open on 60 cycle current. That's almost *twice as fast* as any pilot operated solenoid control valve available today!

All SA Series valves are high performance, full pipe area valves . . . furnished for service on vacuum and air at pressures from atmospheric to 250 psi . . . and at speeds from the most intermittent job in your plant to welding guns. Optional metering valves give simple, sensitive control of piston speed by metering the exhaust air. Exhaust noise is muffled.

The design simplicity of the SA Series valves provides extremely long life and requires a real minimum of maintenance. Only one moving part provides the valving action . . . a corrosion-resistant steel spool and sleeve.

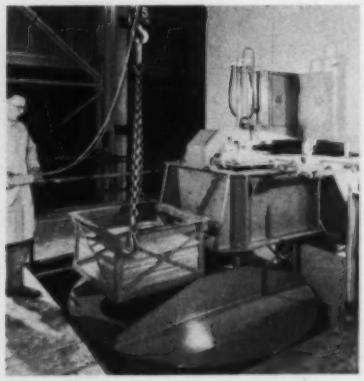
Complete information on the SA Series valves . . . the greatest advance in air controls . . . can be obtained by writing today for your copy of Catalog 8000.

NUMATICS, Inc.

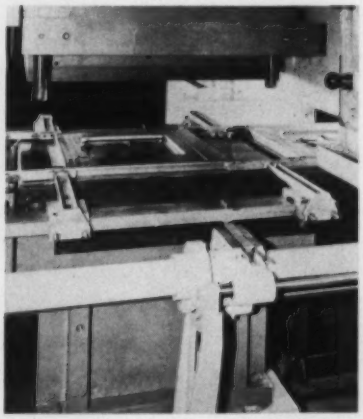
MILFORD, MICHIGAN • **DEPT. A**

green wheels up to 48 inches in diameter and weighing as much as 600 lbs was formerly done manually by two to four men. The green wheels traditionally are subject to spoiling during such handling.

This manual movement has been replaced by the Pneuma-Grip which consists of a steel supporting ring



TRANSFER press which produces two different parts without changing dies has been built by the Clearing Machine Corp. for the General Electric Co. The two parts produced are tops for clothes dryers or clothes washers. Dies for both pieceparts are contained on split slides in the press and are scheduled as needed in a matter of minutes by pushbutton. As illustrated, baskets of blanks can be loaded on a turntable while the press is in production. Turntable automatically indexes 180 degrees and blanks are raised out of the basket by a cylinder and positioned where a feeding mechanism feeds one blank at a time to the press. The transfer feed mechanism, which moves parts between die stations, includes a tubular member on each side of the press. The units move laterally, forward and return, and rotate to import the motion of clamp and unclamp to fingers which grasp the piecepart. The feed mechanism is powered from a gear box mechanically linked to the press drive. The length of stroke and spacing of fingers can be adjusted for different parts.



Circle 671 on Inquiry Card

Plant engineers—here are four examples
where General Electric voltage stabilizing transformers—

SAVE PRODUCTION DOLLARS; PUT EXTRA DEPENDABILITY INTO YOUR PRODUCTION CYCLE

All-around savings result when you use G-E voltage-stabilizing transformers in your plant. You keep expensive automatic equipment *producing*, keep your man-power continuously *productive*, get planned maximum results from your machines. Here are some specific applications where voltage-stabilizing transformers have saved money and made mechanization really pay off:

Computers

High speed computers are only as accurate as their voltage supply is correct and stable. Instant compensation for fluctuating voltage is provided by G-E voltage stabilizing transformers. The transformers keep voltage stable *every cycle* the equipment is operating—prevent relays from dropping out.

Electronic Induction Heaters

Costly maintenance problems are reduced on electronic induction heater applications with G-E voltage stabilizing transformers. Stable voltage permits maximum tube life—assures continuous high-quality production in metal-working plants.

Sequential Relaying

In today's automatic production cycles where each operation is interdependent on another operation, a single component failure because of voltage fluctuation puts the entire line down—production dollars, man hours, are *lost*. G-E voltage stabilizing transformers pay for themselves the first time they prevent a line stoppage due to voltage fluctuation.

Metering and Testing

Your production line power supply can be used for metering and testing if you stabilize voltage at the application. G-E voltage stabilizing transformers installed at the load will stabilize voltage to plus or minus 1% within 1½ cycles. Gives you laboratory test voltages right on the production floor.

These Facts Add Up To This:

First, if you are planning, engaged in, or responsible for an operation requiring production continuity, you need more information on how these G-E voltage stabilizing transformers can meet your specific needs. Make certain, for example, to find how *economical* these voltage stabilizing transformers are—compared to more elaborate, highly expensive stabilization equipment. Highly trained General Electric engineers are ready to provide this information, and put you on the road to greater savings through production continuity. Just call or write your General Electric Apparatus Sales Office or distributor. General Electric Company, Schenectady 5, N. Y.

Send for Free, Illustrated Bulletin!

Section C410-32
General Electric Company
Schenectady 5, N. Y.

Please send me GEA-5754B, Voltage Stabilizing Transformers

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COMPANY.....

STREET.....

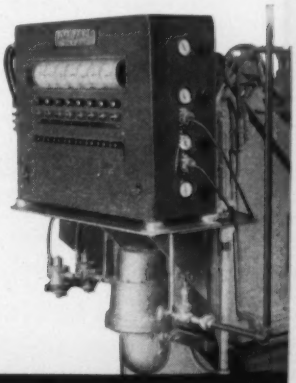
CITY..... ZONE..... STATE.....

GENERAL ELECTRIC

Circle 672 on Inquiry Card

T-P Ingenuity Puts Profit Into Automatic Gaging and Sorting . . . Taft-Peirce Air-Electric Gaging has resulted in a variety of automatic gaging and sorting machine installations. Individual parts are air gaged for size, then dropped into bins marked with size categories. T-P creative engineering makes mass inspection and sorting of parts a profitable reality in your plant.

Taft-Peirce Gaging Stations bring rugged performance plus tight tolerance control to transfer lines . . . T-P equipment handles a multitude of dimensions on a day-in day-out basis, repeating readings without fail. There's one right answer to every automatic or semi-automatic gaging application, so take advantage of specific experience in this specialized field . . . take your problem to the Taft-Peirce Instrument Gage Division.

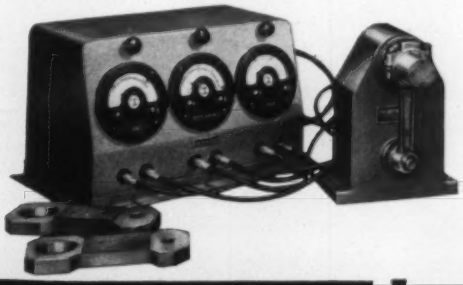


New Versachek Electronic Comparator laboratory accuracy at minimum cost . . . Taft-Peirce provides application versatility plus laboratory pretision, priced to appeal to every shop large or small. Four switch-selected graduations: .0005", .0001", .00005", .00001" — all on one dial. Calibration is simple, with 100% linearity over entire scale. Use a Versachek to police wear on shop working gages, for size control beside the machine, or use special output jack with oscilloscopes, ink recorders, and other inspection devices.

New Packaged Control Center For Simplified Feedback Gaging . . . Here's in-process quality control with minimum investment in equipment. Buy this air-electric control unit from stock and apply it to on-the-machine inspection. All accessory fixturing is available from one source — Taft-Peirce — plus whatever application help you need. Use for size control with pass or reject indicated by pilot lights.

New Functional Styling For T-P CompAIRator Air Gages . . . Special slanted face has glare-reducing visor for easier reading under all lighting conditions. Zero and range setting knobs are within easy reach of the inspector. Plus production-tested T-P Velocity-Venturi Air Circuit for exceptional dependability and accuracy. Use the CompAIRator to sort at the bench with instrument-mounted plug, ring, or snap gage, or at the machine with air hose extension.

Now! Pass or Reject Parts having related dimensions by one computed reading on one dial . . . Patented Taft-Peirce CompUtair streamlines jobs requiring: (1) check of taper between two diameters, (2) alignment or concentricity of two diameters, (3) squareness of bore to face, (4) center distance without respect to hole size, (5) bend or twist developed during machining. Pass or reject a number of product dimensions simultaneously with one composite reading on one dial. You can't beat the CompUtair for speed and economy on any long-run job.



Look what TAFT-PEIRCE is Doing with INSTRUMENT GAGING

New, Electronic Versachek plus redesigned CompAIRator bring wide versatility, extreme accuracy to quality control.

Like to find new ways to do things? Cut corners? Shave costs? Help your company build a better product?

There's almost always a new way to do it with Taft-Peirce Air Gaging! Engineers are continually finding more opportunities to streamline inspection and quality control with Taft-Peirce Instrument Gaging.

Take advantage of all the "tricks to the trade" in gaging. Consult Taft-Peirce for the most advanced, lowest-cost solutions to your problems.

Get all the Facts . . . from your nearest Taft-Peirce representative or write for Air Gage Bulletin No. 613.

TAKE IT TO TAFT-PEIRCE

THE TAFT-PEIRCE MANUFACTURING CO., WOONSOCKET, R. I.

T-P Means TOP Precision

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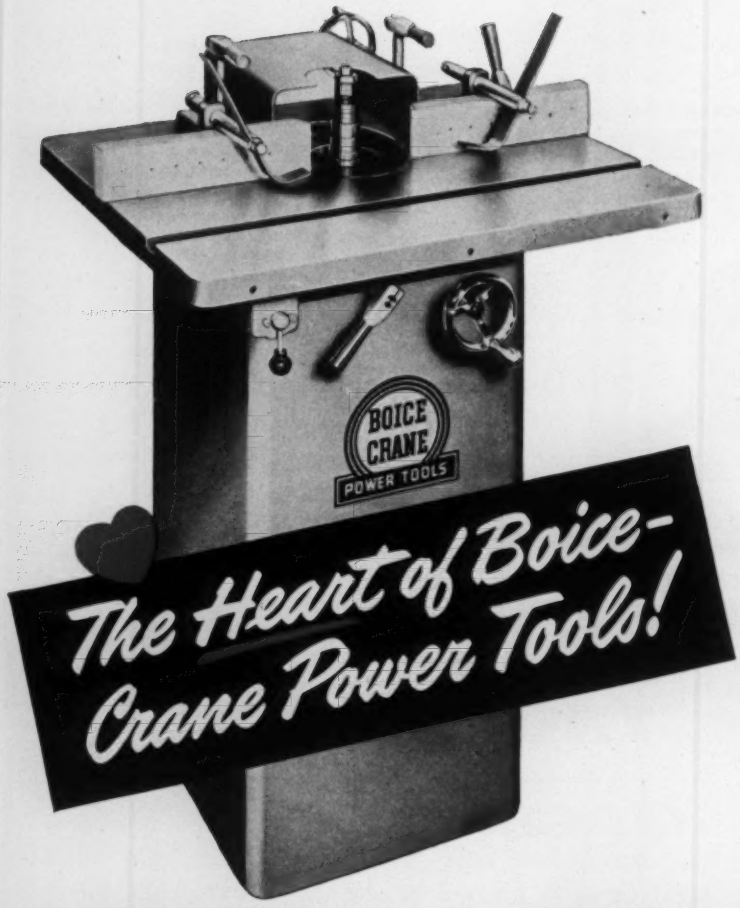

BALDOR STREAMCOOLED MOTORS

For years famous Boice-Crane Power Tools have enjoyed a reputation for faultless performance. And for years, like hundreds of other leading manufacturers, Boice-Crane has specified and depended on Baldor Streamcooled Motors to maintain its enviable prestige.

If customers demand this kind of superior performance from *your* equipment, it will pay you to consult Baldor. Experienced engineers are available to help take the kinks out of all your knotty motor problems . . . *without obligation!*

Rear view of Boice-Crane Spindle Shaper showing vertical installation of Baldor Streamcooled Motor.

Write for Catalogs on Complete Line!

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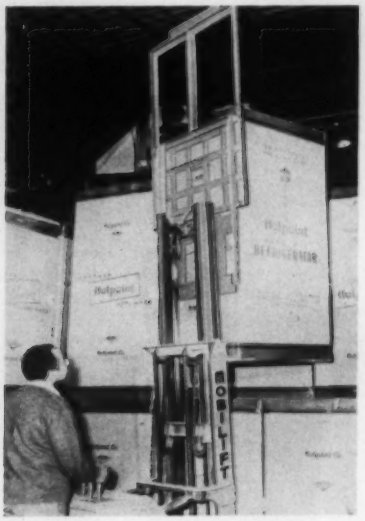
or frame, lined with a pneumatic rubber tire or grip. This assembly is hung from a regular factory hoist by a wire rope sling. Objects are lifted and moved by positioning the device around them and inflating the grip with compressed air. The object is gripped firmly without damaging delicate surfaces. A simple push-pull air valve controls the flow of air in and out of the tire.

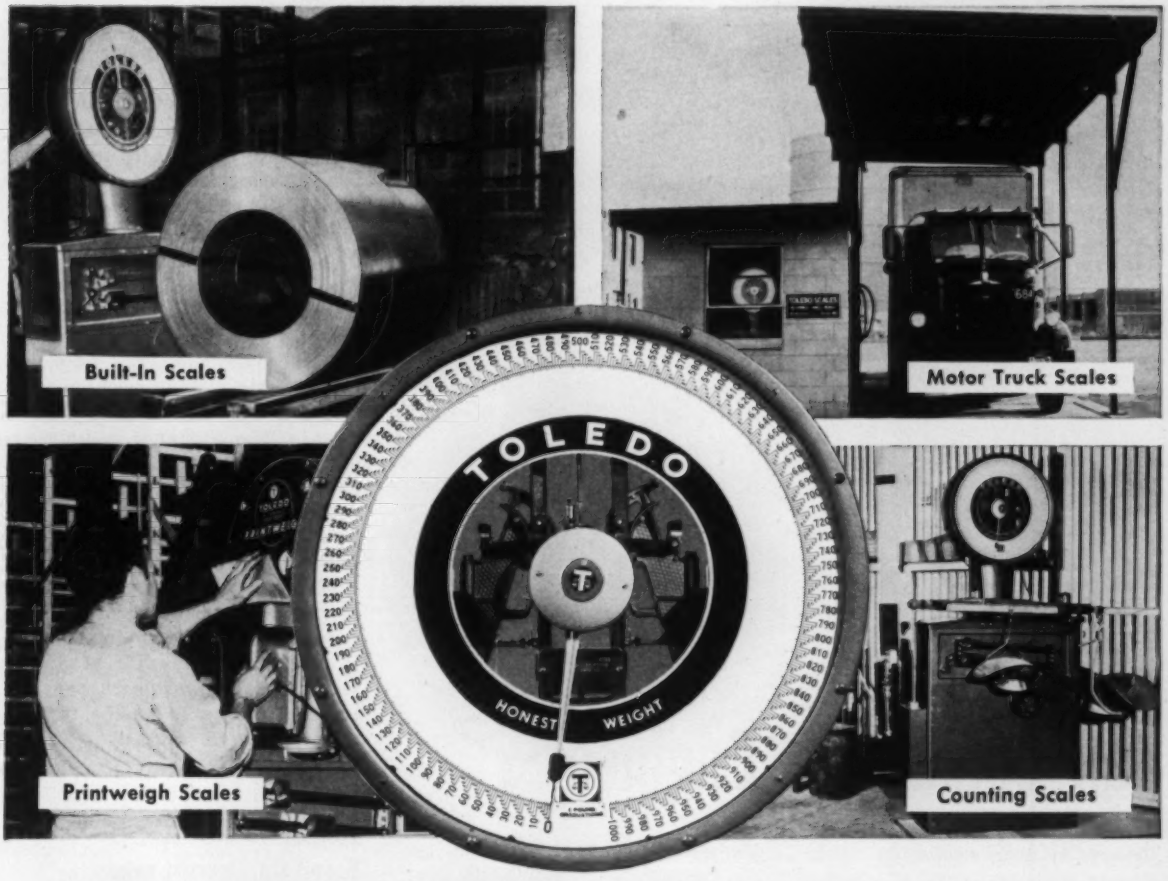
The device can be shaped to fit any desired product and is potentially useful for handling products such as appliances, foundry cores, ceramic parts, fiber drums, newsprint and furniture.



APPLICATION of industrial trucks can be expanded by the use of devices and attachments which speed operations and cut costs. For example, the Lamson Corp. reports that with a simple rack attachment, 11 cu ft refrigerators are stacked three high by the Paul-Jeffrey Co. Inc., a warehousing firm. The lower lip of the rack is used for stacking the boxes two high while the upper lip is used for tiering boxes three high. The attachment eliminates the need for pallets and prevents damage due to forks piercing a box. Aisle space is saved since no room is required to maneuver the forks.

Designs Transistorized Computer

TWO completely transistorized computers are being constructed by the Government and Industrial Division of Philco Corp. The data processing system incorporates a combination of transistors and printed circuitry developed by Philco for airborne control sys-



THIS FAMILIAR FACE . . . helps solve plant-wide cost control problems *Everywhere!*

This "face" identifies dependable, versatile Toledo scales. You'll see it plant-wide wherever managements see weighing in its true perspective—*as a vital element in the overall cost control system.*

This means the right scales in the right places . . . to supply basic accounting records of materials received, processed, shipped or transferred. Weight records directly affect costs, inventory, quality and customer relations. They are *fundamental* to sound cost control. Today's pressure on profits calls for integration of weighing in a *plant-wide weighing system.*

To learn the job *your* scales are now doing, we invite you to send for the new Toledo Weight Fact Kit. It will help you determine how well your scales measure up as a weighing system—help you detect weighing inefficiencies that drain profits. **REQUEST YOUR WEIGHT FACT KIT NOW.** No obligation. Address Toledo Scale Company, 1415 Telegraph Road, Toledo 1, Ohio.

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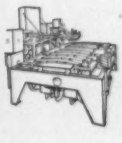
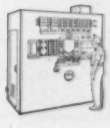
CUSTOM PRODUCTS FOR INDUSTRY

REMOTE DIGITAL WEIGHTS. Toledos automatically transmit weights to electric office machines located anywhere.

ELECTRONIC SCALES give electronic wings to weights; head may be located anywhere.



TESTING Toledos today test a wide range of parts; this device for leaf springs.



AUTOMATIC BATCHING SYSTEMS interlock batteries of scales.

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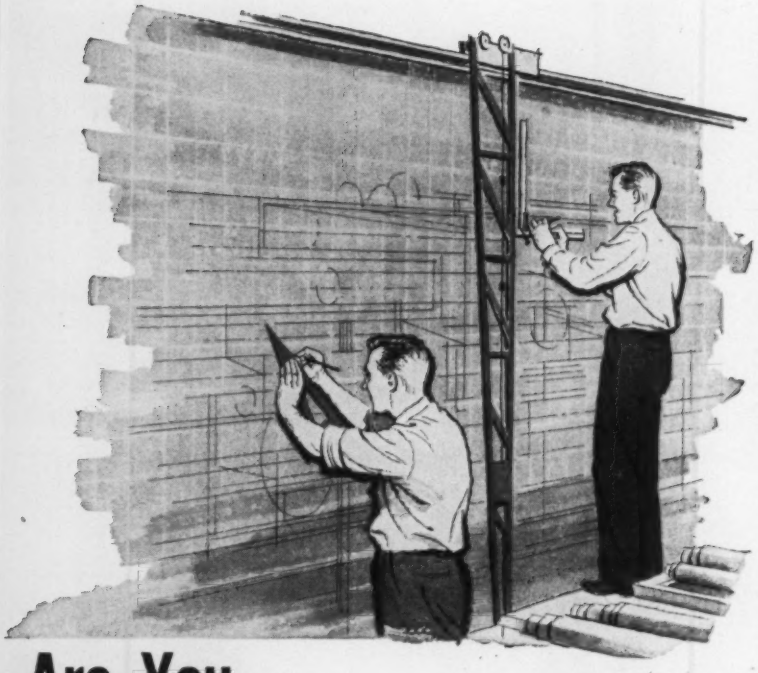

Are You an Engineer's Engineer?

Then you will enjoy meeting the men at Pioneer. Here are gathered together the most versatile and competent staffs of product development and design engineers you can imagine.

They are real engineers' engineers. There is nothing in the world to them like getting their teeth into a product design and development, or improvement project.

As every engineer's engineer has to be, they are thoroughly practical. If you wish, they can help you right from the sketch or idea stage through all phases, including a complete set of manufacturing drawings. What's more, these drawings will guarantee the most economical production costs. They can help you with development, with styling for today or tomorrow, with engineering analysis, production methods and tools, on prototype building and testing, performance analysis and specifications.

Industry has called on them on over 264,000 jobs in the past 25 years. Working with engineering staffs like yours, they are trained to assemble ideas from their experiences in dozens of fields and apply them to the development of a better, more economical, more saleable, MORE PROFITABLE product in a still different field . . . yours!

You can write your own specs as to what you want them to do for you, and how. They'll be part of your team. They are a real engineer's engineers . . .

P. S.—Pioneer's Chief Engineer has some material he'll be glad to send you, giving more details on our services. Ask him for Bulletin PE-60

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19669 John R Street, Detroit 3, Michigan

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BRANCH OFFICES IN DAYTON, OHIO, WASHINGTON, D. C. and TORONTO, ONT., CAN.

tems. Generating comparatively little heat, the computer requires only a fraction of the air conditioning equipment normally required for large scale computers. Equipment will require no special power wiring and may be plugged into existing 110 volt, 60 cycle outlets.

Occupying only 256 square feet, the system consists of a central computing unit, a paper tape input and output and magnetic tape units. The magnetic units use tape similar to that used on home or commercial tape recording equipment. The computer has a magnetic core memory for high speed internal storage (256,000 characters of information) and can perform 39,000 additions per second, 39,000 subtractions per second, 12,000 multiplications per second or 10,000 divisions per second. The computer will accept information from tape at the rate of 15,000 alpha-numeric characters per second and can write on the tape at the same speed.

Remote Control System Based On Aircraft Type

REMOTE positioner for industrial applications as been introduced by Lear Inc., based upon an original version developed for aircraft applications. The industrial version has adapted the original to standard commercial power supply, and adds engineering refinements developed from company experience with the device. The remote positioner weighs only 16 lb and is adjustable to varying requirements; it reaches maximum speed in 1/50-second and is accurate within ½-degree.

Unit consists of three basic components: A data link which converts manually positioned inputs into an error voltage; and amplifier which processes signals from the data link and a velocity signal from the servodrive; and the servodrive which incorporates an integral generator and provides power output to the load.

Because of the rate of response and reproducible accuracy, the unit represents a noteworthy advance in electrical servomechanisms. Remote control systems which require

Circle 676 on Inquiry Card

a high torque output have been almost exclusively hydraulic; the new unit combines a high response and the simplicity of electrical servos with the torque output normally associated with hydraulic systems.

MEETINGS AND EVENTS

June 11-13—

Western Plant Maintenance and Engineering Show. To be held Civic Auditorium, San Francisco. Additional information may be obtained from conference headquarters, 795 Monadnock Bldg., San Francisco 5, Calif.

June 12-14—

Illinois Institute of Technology. Operations Research Conference to be held on university campus, Chicago. Additional information may be obtained from Conference Co-ordinator, Illinois Institute of Technology, 3300 S. Federal St., Chicago 16, Ill.

June 13-14—

Society for Advancement of Management. Second Annual Material Handling Conference to be held Hotel Statler, New York City. Additional information may be obtained from SAM headquarters, 74 Fifth Ave., New York 11, N. Y.

June 19-21—

Association for Computing Machinery. Twelfth Annual Meeting to be held University of Houston, Houston, Tex. Additional information may be obtained from association's 1957 Meeting Headquarters, University of Houston, Cullen Blvd., Houston 4, Tex.

June 26-29—

American Association of Cost Engineers. First annual meeting to be held University of New Hampshire. Additional information may be obtained from Dr. Irvin Lavine, Industrial Research Service, Masonic Bldg., Dover, N. H.

July 29-Aug. 2—

National Machine Tool Builders' Association. Annual joint sales conference with American Tool Distributors' Association to be held

We can be a working partner in

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Call on *Continental*

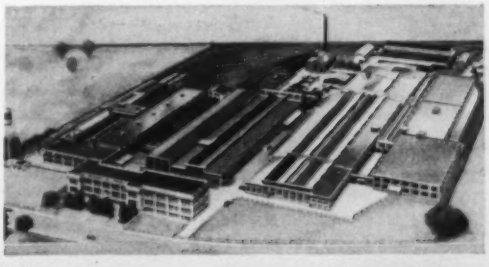
for experienced and capable help in producing your special machines, conveying and parts-handling systems. There's no need to tie up your most valuable engineers and productive facilities. Let us show you how Continental can work like your own Special Machine Development Department.

Our facilities are entirely capable of handling your job, just as they have handled similar jobs for many of the nation's largest industrial firms. Our engineers and craftsmen are skilled in working to exacting specifications and minute tolerances. Our standards of quality in design, workmanship and performance are rigid — and high. And we are accustomed to keeping the job strictly confidential when required.

A call, telegram or letter to your nearest Continental office will bring a representative to discuss your problem.

MAKE THIS PLANT YOUR "SPECIAL" DEPARTMENT

Our 10-acre Birmingham plant contains a Meehanite foundry, the South's largest modernly equipped machine shop, a complete fabricating and assembly plant. All staffed and readily available for your use.



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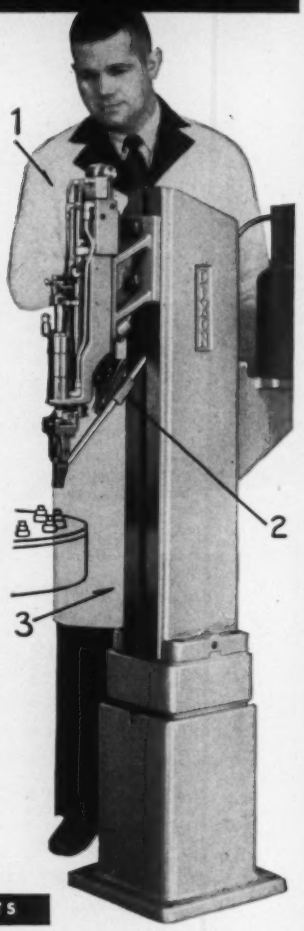
Announcing New Standard DIXON "Auto-Positioner"

SIMPLIFIES SMALL PARTS ASSEMBLY OPERATIONS



AUTOMATICALLY GUIDES PARTS OF 1/16" TO 3" O.D. SIZE AT RATES UP TO 7200 PER HOUR

The new Dixon "Auto-Positioner" combines three standardized units — (1) Escapement, (2) Automatic Positioner, and (3) Mounting Structure — and now provides an economical solution for automating small parts assembly operations. "Auto-Positioners" are easily arranged at single or multiple stations with fixtures, feeders, feed tracks, transfer or indexing tables. The positioner, properly tooled with a proven feeder, can place parts at rates up to 7200 pieces per hour. Full electrical controls are included with provisions for automatic interlocking.

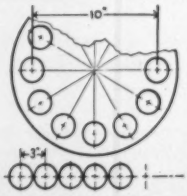
FEATURES OF STANDARDIZED UNITS

1-DIXON PARTS POSITIONER—a compact, self-contained air-operated automatic cycling unit with exclusive built-in sensing features. Automatically stops your machines when parts are missing or malformed. Handles parts of 1/16" up to 3" O.D. size. Engineered for mounting individual chuck jaws to suit varied requirements. Four standard models available with 1", 2", 3", 4" strokes.

2-DIXON PARTS ESCAPEMENT—Automatically releases single parts or in multiples at speeds up to 200 piece-parts per minute. Blank rear finger is easily shaped to suit piece-part. Standard models available for air, solenoid, or mechanical operation.

3-DIXON MACHINE STRUCTURE—includes rugged semi-steel column with machined T-slots, sturdy base, and spacer blocks to suit varied locating and operating requirements. Compactly designed to fit in small space. Special support brackets available for feeders, work tables, etc.

INDIVIDUAL UNITS OR ANY COMBINATION OF STANDARD COMPONENTS AVAILABLE FROM STOCK. TOOLED "AUTO-POSITIONERS" PROVIDED TO SUIT NEEDS.



May be located at adjacent stations, only 3" apart for straight-line indexing, or on 12-station dial with a 5" fixture radius.

DIXON

WRITE FOR FREE DATA SHEETS
New bulletins supply specifications and application data on standardized units now available from stock.

DIXON AUTOMATIC TOOL, INC.
2312 - 23RD AVENUE ● ROCKFORD, ILLINOIS
AUTOMATIC PARTS HANDLING AND ASSEMBLY EQUIPMENT

Cornell University. Additional information may be obtained from NMTBA offices, 2071 E. 102nd St., Cleveland 6, O.

Aug. 28-30—

Instrument Society of America. International Symposium on Gas Chromotography to be held Kellogg Center for Continuing Education, E. Lansing, Mich. Additional information may be obtained from H. J. Noebels, General Chairman, IGC Symposium, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Sept. 9-13—

Instrument Society of America, Twelfth Annual Instrument-Automation Conference and Exhibit to be held Cleveland Auditorium, Cleveland. Additional information may be obtained from H. S. Kindler, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Sept. 17-18—

Radio - Electronics - Television Manufacturers Association. Symposium on Numerical Control Systems for Machine Tools to be held Ambassador Hotel, Los Angeles. Additional information may be obtained from RETMA, Room 650, 11 W. 42nd St., New York 36, N.Y.

Oct. 7-9—

Second Conference on Manufacturing Automation. Co-sponsored by Purdue University and AUTOMATION Magazine to be held Purdue University. Additional information may be obtained from the Editor, AUTOMATION, Penton Bldg., Cleveland 13, O.

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You can expect extremely long life from Skinner Solenoid Valves. Here's why...

In the lab shown above, dozens of Skinner valves are life-cycled 24 hours a day, 7 days a week, at speeds as high as 600 cycles per minute. It is here that we try out new designs, new materials, new construction methods. It is here that we test the stability of our welded joints . . . the resistance to burnout of our coils . . . the effectiveness of our positive spring returns . . . the better seal we obtain by eliminating packings. And it is here we find positive proof of Skinner valves getting over 20,000,000 cycles without leakage.

Service records of many millions of trouble-free cycles indicate that these constant laboratory tests are worthwhile and necessary to assure outstanding performance on critical applications.

For complete information on Skinner's line of 2-, 3- and 4-way valves, write us or contact a Skinner representative. Write Dept. 326.

Skinner Solenoid Valves are distributed nationally

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SKINNER ELECTRIC VALVE DIVISION

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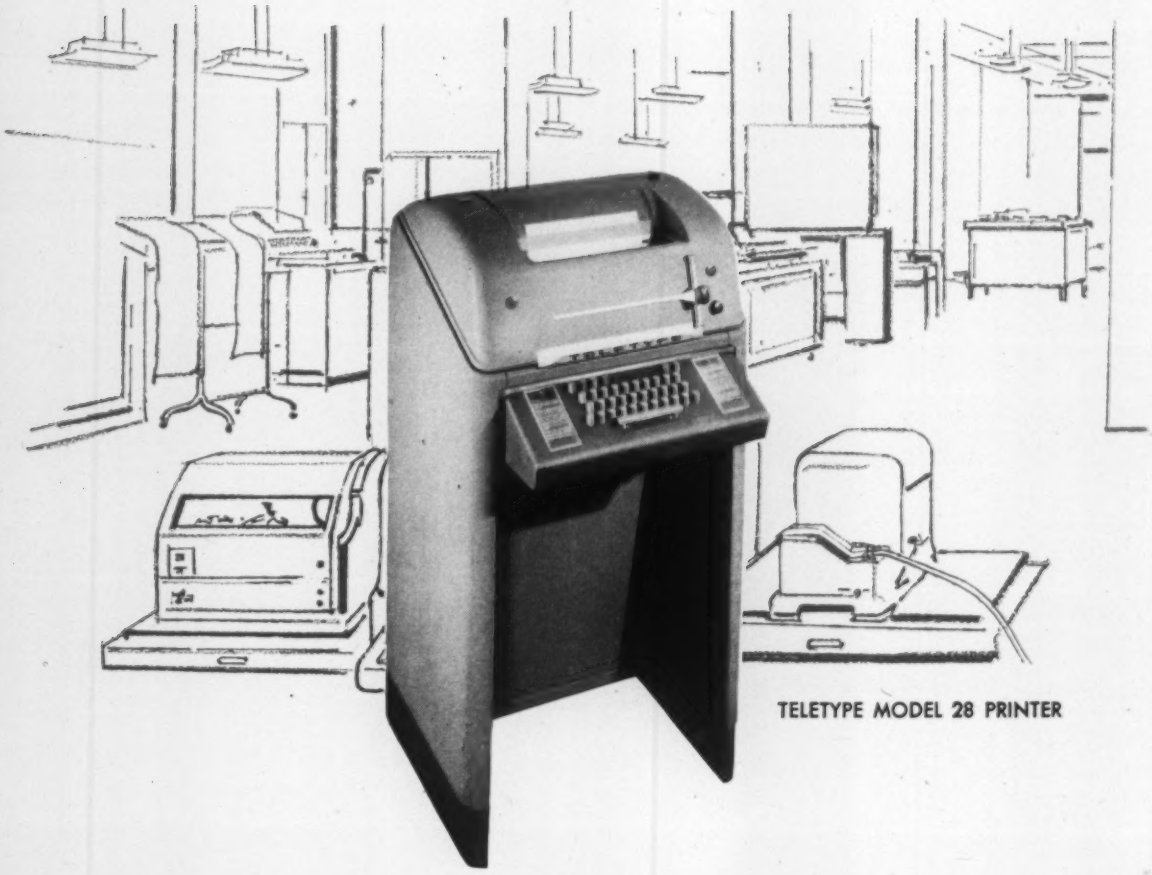

TELETYPE MODEL 28 PRINTER

Key role in automation!

Though the word "automation" itself is barely ten years old, Teletype Corporation has been helping to bring the advantages of automation to business and industry for more than forty years.

Today, Teletype page printers and perforated tape equipment help coordinate assembly line operations . . . process customer orders from the original sale to the ordering of needed materials . . . flash intricate raw data to computers and re-transmit the answers. Indeed, Teletype machines — and ideas — have made many of yesterday's dreams a daily part of today's business world.

We would like to send you a copy of our booklet, "The ABC's of Teletype Equipment." Address your request to Teletype Corporation, Dept. AU6, 4100 Fullerton Avenue, Chicago 39, Illinois.

TELETYPE®

TELETYPE CORPORATION

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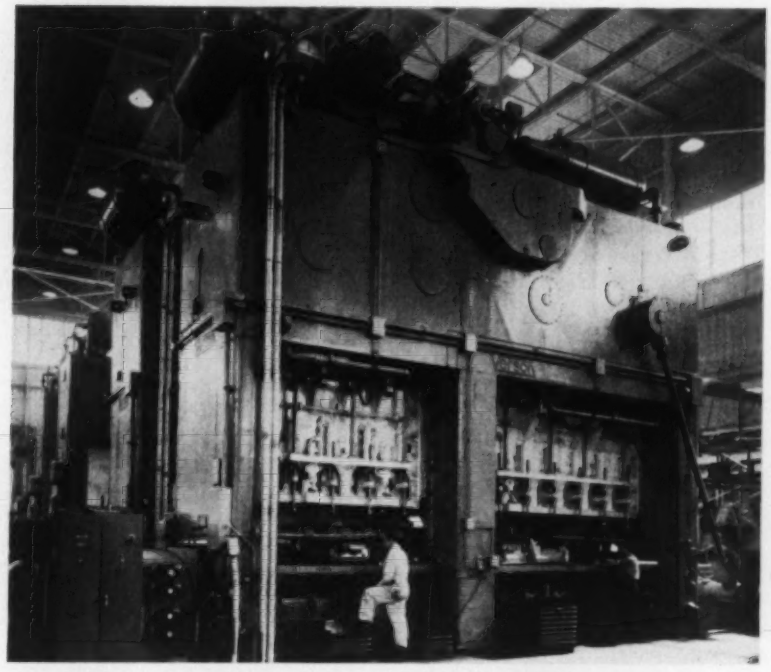
1957 Golden Anniversary Year

Circle 681 on Inquiry Card.

By JAMES C. KEEBLER
Associate Editor



Verson 2200-ton, four-point suspension Transmat press at Ford Motor Co.'s Automotive Chassis Parts Plant, Sterling, Mich. This two-slide, 12-station press forms front suspension arm units.

Automation On-the-Hop

FORD's John S. Bugas, vice president-industrial relations, was called upon to deliver one of a series of addresses sponsored by the Labor and Industrial Relations Center of Michigan State University: subject—"Industrial Relations Patterns for 1975." Bugas hopes that, ". . . by 1975, reasonableness and responsibility will have come to replace emotional hysteria and naked force as the dominant characteristics of the bargaining process."

Flip Flop

It is a simple flip of the digits to make '75 out of '57, but to flop the hostility of '57 into docility in '75 will take a lot of doing.

Bugas' speech lists two things that might destroy collective bargaining between now and then: "First one side or the other might possess such dominant economic power that bargaining in form would be dictation in fact. Secondly, one side or the other might gain such great political power that collective bargaining would largely be supplanted by government regulation." His observations on the nature of the parties he bargains with revealed his feeling that union leaders are ingrained with a concept that they must appear ". . . to their constituents as fighters . . . union leadership would have to invent an adversary if it did not have one."

This kind of talk rankled Walter Reuther into statements that reveal he's willing to continue potshotting at the same old adversaries. Reuther announced his contradiction to a Bugas assertion that growing labor costs have outstripped productivity, profits, and in point of time, prices. He had a few assertions of his own. In his version of the present state of inflation, it's not the high cost of wages and fringe benefits that's wrecking the economy, but the high price tags a handful of corporate executives have put on the cars they sell. The UAW suggests the Senate investigate auto pricing.

Points of Agreement

When Mr. Bugas says that Mr. Reuther just wants to fight; in agreement, Mr. Reuther seems to say, "That's right." At the mention of wages dominating the economy, a counterclaim is made for prices; when it is suggested that political power might tip the scales, the response is to call out the Senate.

There is also agreement on another point: Public sympathy for one's cause is a valuable asset. The public can only hope that in the long run both sides will come to realize that bargaining is different than fighting and that the really good bargains are those in which both parties make a profit. But can labor and management both get more without taking it out of the customer's hide?

Labor unions that bargain for laborers have a product to sell—results of human effort. Salesmen who make themselves obnoxious breed disrespect for their product. Labor relating is probably the only field of endeavor where bargainers go to such great lengths to publicize the shortcomings of the fellow on the other side of the counter.

Automation In the Middle

As a broad horizontal technology, automation is exposed on all sides and has been kicked from most of them. Labor may pretend to despise automation, yet their own actions make automation more desirable. Higher wage rates make automated installations more readily justifiable by economic analysis. From this angle the more wage increases the unions succeed in forcing—the more automated equipment they can expect to see installed. The trick then is to keep these factors in balance. Let the benefits of increased automation go to both parties and the cus-

tomers on the bases established by rational bargaining.

So far as automation is concerned Bugas had this to say: ". . . it is clear that meeting the needs of our society and at the same time avoiding serious perennial inflation will require steady increases in both the productivity and output of our industrial system. This means that in the interests not only of industrial workers but of Americans in all fields of endeavor, we must have a rapid development of technological progress — which means no direct or indirect barriers to the evolutionary process that has come to be called 'automation'."

Money In the Till

It is logical that in order for businessmen to make more money for everyone to divvy-up and take home, maximum use must be made of the business facilities.

There's an enthusiast of punch-press automation who likes to tell about the check-out girl in Mills Cafeteria that runs her adding machine "on-the-hop" during rush hours. The roll continues to index the tape upwards and she punches keys as fast as the roll indexes.

Presses that are set up on an automated basis and run on-the-hop mean maximum use of facilities and have the same encouraging "money-in-the-till" jangle that accompanies top-speed operation of a check-out adding machine. Since running in this manner does not involve use of clutch and brake with each stroke it can also be assumed that maintenance of these items is thereby reduced.

Ease with which a whole sequence of press operations can be made to run on-the-hop is a contributing factor to the present popularity of bigger transfer-feed presses in automakers' shops.

At Ford's chassis parts plant at Sterling, Michigan, three intricately shaped parts are being formed on Verson Transmat presses. This represents a further extension of the capabilities of transfer feed forming far beyond the narrow limitations that existed only a few years ago. The Transmat press is an automatic machine for producing multi-operation stampings which get no intermediate handling, pickling or annealing. Piece parts may be formed either from coil stock or pre-blanked stock, depending on scrap economy.

The parts being formed at Ford are front arm suspension units, spring seats and rear axle housings. Two 2200-ton, 4-point suspension, 12-station Transmats form the front suspension arm units. A 2200-ton, 3-point suspension, 11-station Transmat forms rear axle housing banjo halves. A 1000-ton, 2-point suspension, 10-station Transmat forms the spring seats, with two sets of tooling provided to make it possible to produce either automobile or truck spring seats on the same press.

Besides being able to link all dies with one transfer actuator there are other advantages to having all operations in one press instead of having a separate press for each die. These include: (1) Saving on initial equipment cost, (2) saving on floor space, (3) saving on complicated interlocking controls, and (4) saving on setup time.

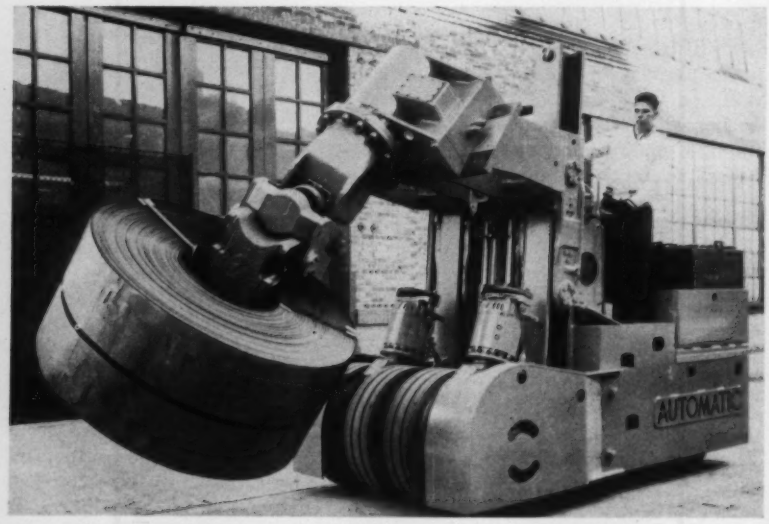
To put flexibility into transfer-feed presses Clearing has designed a modular system which enables their Transflex press line to be used as building blocks to construct an integrated line. A setup for automobile wheels consists of four crowns, four slides and beds, and five uprights. It has only one clutch, brake and flywheel assembly and one Transflex gear box.

Other features Clearing uses for flexibility in automated operations are: adjustable transfer feed stroke and the accompanying necessary facility to respace feed fingers, cushions and knockout positions to accommodate various numbers of dies and varying feed lengths. Multislide arrangement enables unbalance of load in different stations without causing the distortion that would take place if all dies were mounted on the same slide. This is carried a step further with the use of split slides and a skip stroke feature that enables simultaneous production of two different parts on the same press.

Keep Them Hopping

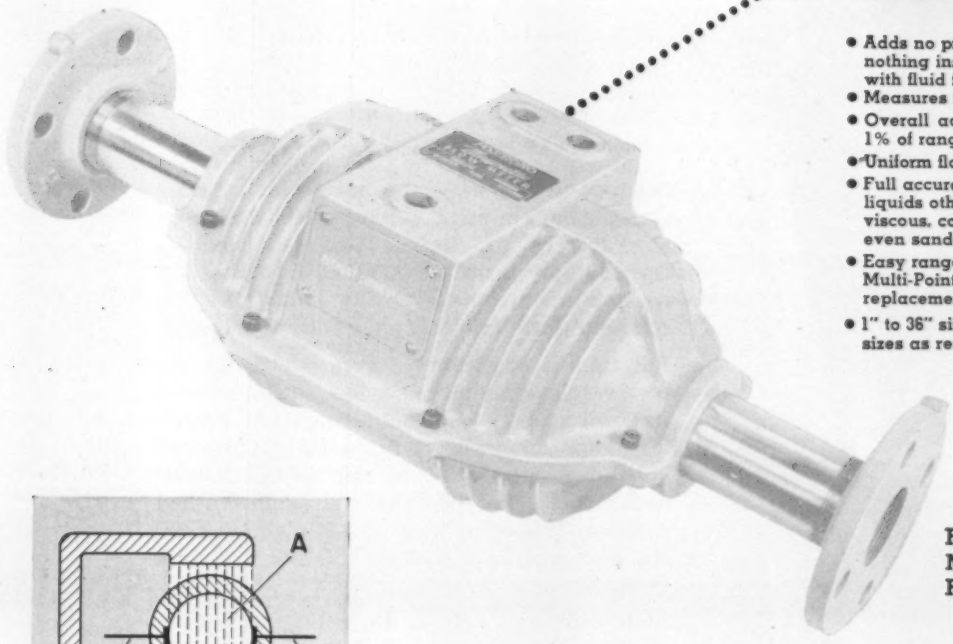
Big presses that run continuously have big appetites. They must be kept supplied with material. Flexibility at the start of such lines can be achieved by use of fork lift trucks that are equipped to handle coils or stacks of blanks being supplied to a decoiler or first-station feeder. Though not automatically linked to the system, such equipment plays a big part in the success of an automated press line.

Lift trucks can handle the weighty problems of moving stock to automated production lines. Let's hope that by 1975 Messrs. Bugas and Reuther find a device that can maneuver their weighty problems with equal effectiveness.



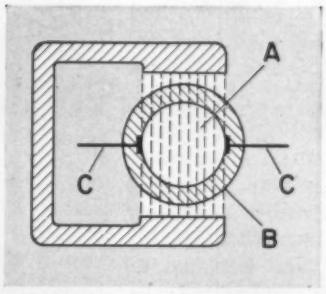
Lift truck attachment by Automatic Transportation Co. handles coils up to 60,000 pounds. Ninety degree rotator, offset 45 degrees from the vertical eliminates need for a separate coil up-ending unit.

Now! a flow meter with no flow restrictions!



- Adds no pressure drop — nothing inside pipe to interfere with fluid flow.
- Measures fluid velocity directly.
- Overall accuracy better than 1% of range over entire scale.
- Uniform flow scale.
- Full accuracy sustained even on liquids other meters can't handle: viscous, corrosive, or pulpy — even sand-water slurries.
- Easy range change — either by Multi-Point Switch or range coil replacement, as preferred.
- 1" to 36" sizes standard — larger sizes as required.

FOXBORO MAGNETIC FLOW METER



SIMPLE, TROUBLEFREE, OPERATION

The Foxboro Magnetic Flow Meter operates on the same principle as a power generator. A magnetic field (A) is maintained through a standard pipe section (B) of stainless steel or other non-magnetic material. This pipe section is lined with Kel-F® or other insulating material. Liquid passing through pipe acts as moving conductor, generating an electric voltage which varies in proportion to liquid's average velocity. Flush electrodes (C) in pipe wall "pick up" this voltage which is recorded in desired flow units by Dynalog Electronic Recorder or Controller.

This premium-performance meter measures *magnetically* the flow rate of virtually any liquid except hydrocarbons. It completely ignores such common metering headaches as turbulence, suspended solids, and variations in conductivity, density, and viscosity. It even measures reversing flows.

Installation is simple. The magnetic spool piece connects into the line like any equivalent length of pipe — no seals, purges, meter runs, or straightening vanes required. Connects by 2-conductor cable to remote Dynalog Electronic Flow Recorder.

Maintenance is practically eliminated. There are no pressure taps to become plugged or frozen, no working parts to foul.

Foxboro Magnetic Flow Meters are already in use on such widely different liquids as beer, sand-and-water, rosin size, rock-and-acid slurry, viscose, and highly corrosive liquid detergent. Find out how this precise, troublefree flow meter can help your processing. Write for Bulletin 20-14A.

THE FOXBORO COMPANY, 126 NORFOLK STREET, FOXBORO, MASS., U. S. A.

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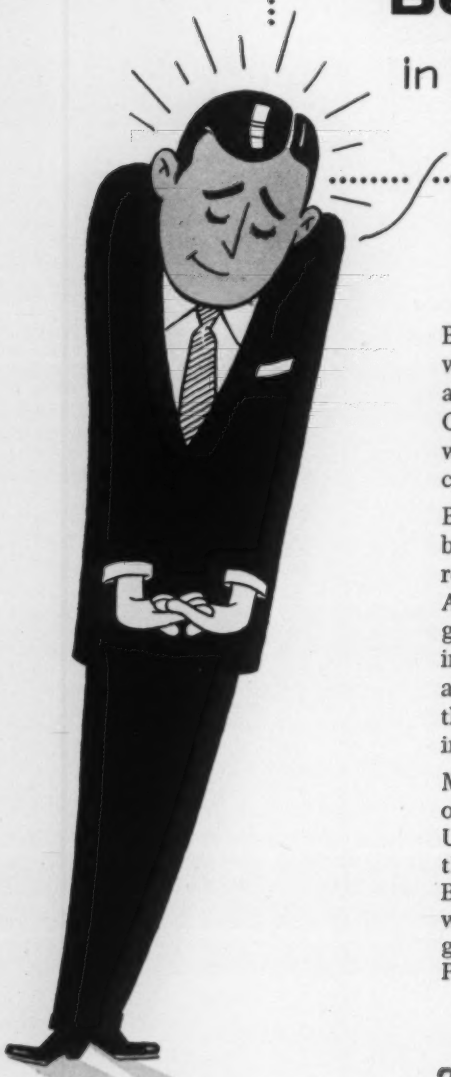
Foremost in FLOW METERING

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

We hate to admit it but we had trouble with a

Bellows Air Motor

in Reading, Pennsylvania



Bellows Air Motors — the unique air cylinder with the built in valve — have established enviable records for trouble free performance. Operating cycles of 20,000,000 to 30,000,000 without maintenance of any kind are quite common. Fifty million cycles nothing unusual.

But trouble sometimes occurs — even in the best regulated families. A few weeks ago we received a phone call late at night. A Bellows Air Motor on an important production line had gone haywire. Could we ship a replacement immediately? We did better than that. We had a Bellows Field Engineer at his plant at 8:00 the next morning. At 9:00 the line was back in operation.

More than 125 Bellows Field Engineers (one or more in every major industrial area in the United States and Canada) are your assurance that if you ever do have trouble with any Bellows equipment it will be remedied quickly with minimum down time. (But between us girls, trouble with Bellows "Controlled-Air-Power" Devices is most unusual!)

The Bellows Co.

AKRON 9, OHIO

MANUFACTURERS OF CONTROLLED-AIR-POWER DEVICES FOR FASTER, SAFER, BETTER AND LOWER-COST PRODUCTION

830-B

By FRANK G. WOOLLARD
British Correspondent

Trivial But Vital

IF FIRMS that supply conveyors are excluded there is, so far as the writer is aware, only one company in Britain that has as its declared objective the manufacture of inter-operation mechanisms. There are, of course, many concerns who supply pneumatic or hydraulic components and they will usually provide circuit diagrams for the guidance of the purchaser and, occasionally, they may even make up a complete rig to customers' drawings. This, however, is outside their normal routine and could only be regarded as a favour. There are, in addition, a number of general engineers who will build linking devices to drawings supplied by their customers.

To date most of the users firms are, apparently, prepared to make their own linking mechanisms rather than to place orders with a specialist contractor. This would seem to be due to: (1) A lack of knowledge regarding the services that a specialist contractor can offer; and since there is only one such contractor there is a lack of competitive publicity to make these services generally known. (2) There is a prevalent belief that user companies can through the tool room or maintenance departments build the devices much more cheaply than they can buy from a specialist concern. This is usally due to a misconception regarding the actual overhead costs incurred on this special work. (3) It is also, perhaps more legitimately, due to using this work as a balancer for the service departments. Yet this is a fallacy because as a result more highly skilled craftsmen are carried than might normally be necessary.

All this is an old argument which applies to all bought out goods—particularly to jigs and fixtures. The writer does not propose, however, to enter the lists on one side or the other on this occasion.

What is there to be said on the other side? First and foremost there is the experience of the specialist firm, obtained from handling very large numbers of different jobs, which gives the specialist an opportunity for building up a store of fundamental criteria in design which can only be acquired by long experience in a particular field. This advantage is denied to the smaller users although it is available to the great corporations. Such a fund of information enables the specialist quickly to analyse the problems presented and to offer an adequate if not the one best solution. This wide experience also ensures that the device offered will give satisfactory performance coupled with long service. It is, in fact, a guarantee of practicability and reliability.

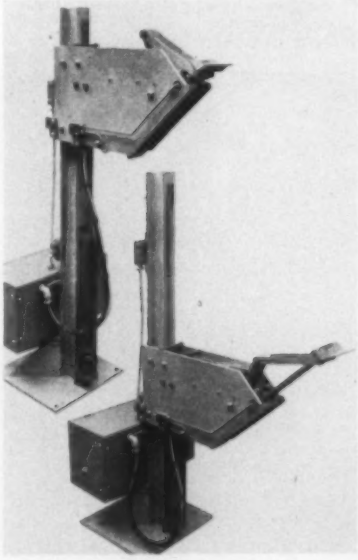


Fig. 1—Workpieces are transferred from an overhead conveyor to a machine by this device. The arm shown is fitted with an angle piece to pick up a plain cylinder; other fittings can be designed as needed.

The cost to the specialist company in becoming a specialist is high and it is greater than any amount that could be funded by any user company unless among the industrial giants. All this know-how is available to any purchaser from a specialist concern.

One must not overlook the fact that many linking devices are ephemeral in nature and these should properly be charged to revenue rather than to capital account. This applies to all small tools and gauges, and often applies to fixtures and jigs. Hence the argument that revenue items must be made at home has no validity since small tools are invariably bought from specialist firms.

Some Examples

The foregoing illustrates the arguments that are current in Britain but it is, perhaps, more practicable to show samples of what is being done in linking devices in Britain. The examples are shown by favour of the Hymatic Engineering Company Limited who are specialising in automation equipment. They are taken at random to cover a number of different applications. Some of these devices would, to an older generation perhaps, appear to be trivial in the work that they carry out. *Trivial but vital* because they maintain the continuity of work flow without human intervention and without having to take into ac-

(*Continued on Page* 48)

3 WAYS YOU CAN KEEP

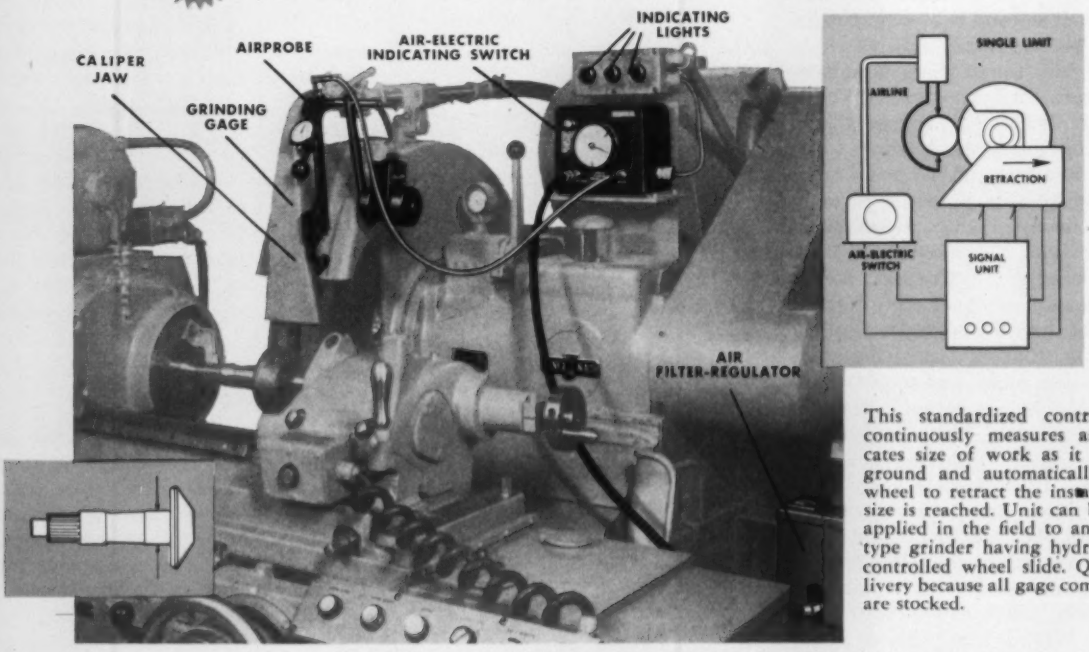
A BETTER PRODUCT . . . AT LESS COST . . . THROUGH ADVANCED GAGING . . . . . .

Profit margins aren't getting any better . . . just the opposite. With buying appetites fairly well satisfied, it's no longer a matter of "getting the stuff out". The problem now is making it *better at lower cost.* You certainly don't plan to let competition catch up to you. So consider these ways of improving product quality and, at the same time, cutting down on the cost per piece. Advanced gaging — by FEDERAL — can do it. The gaging ideas are proven profit makers. The gages, far from being monsters of automation, are compact, standardized units, realistically designed to provide automatic control or inspection, or both, where it does the most good and at a price that practically *every* manufacturer can afford. And they have reliability . . . the most important single feature of FEDERAL Gaging.

Whether you're big or small in terms of production, ***at least one of these gaging arrangements can pay off for you.*** *It's the truth. Ask us to prove it. Write:*

FEDERAL PRODUCTS CORPORATION
7396 Eddy Street, Providence 1, R. I.

1 AUTOMATIC CONTROL OF FINISH SIZE



This standardized control gage continuously measures and indicates size of work as it is being ground and automatically causes wheel to retract the instant finish size is reached. Unit can be easily applied in the field to any center type grinder having hydraulically controlled wheel slide. Quick delivery because all gage components are stocked.

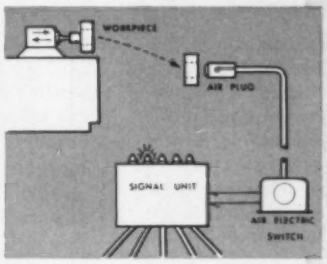
BENEFITS: *Reduces cost of operation — permits one operator to handle two, possibly three grinders performing the same or different operations. In this way gages pay for themselves within a few months.*

Improves quality — even if you have only one grinder, gage is a profit-maker because it eliminates error due to operator inattention or fatigue and also eliminates cost of later inspection. Gage never tires, is accurate to .0001" or better, is easily adjustable to control different sizes of work. Its Air-Electric system overlooks minor workpiece surface irregularities which confuse size readings of other gages.

VARIATIONS: *Similar FEDERAL Gages are available through machine tool manufacturers to also change wheel feed rate to dwell grind . . . or to control dressing cycle and finish size on I.D. grinders. When specifying machine tool requirements be sure to include* FEDERAL *Gaging.* FEDERAL *maintains close engineering alliance with all leading machine tool manufacturers.*

AHEAD OF COMPETITION

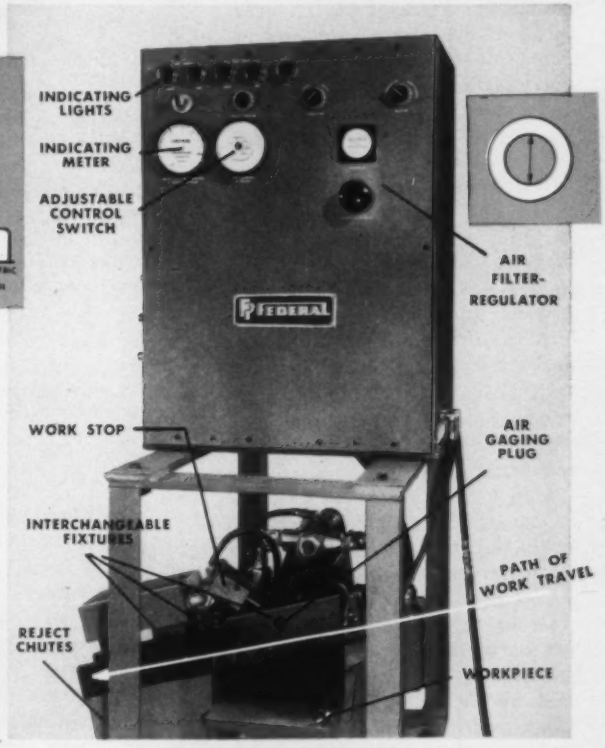
2 AUTOMATIC 100% INSPECTION

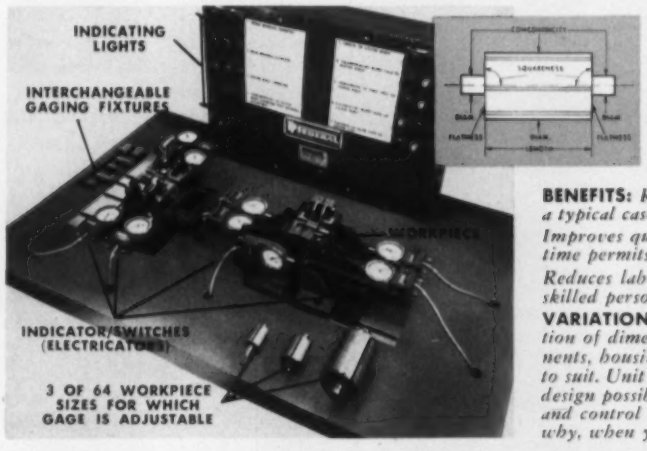


This standardized "post-process" gage inspects every part as it is discharged from the machine and sorts work into "good", "near-over", "near-under" plus "salvage" and "scrap", indicating the size of each piece as it is gaged. Operator, watching large indicating lights, can compensate machine for drift and piece-to-piece variation *before any scrap parts are produced.* Unit can be applied to any type I.D. or O.D. grinder, lathe, boring machine or screw machine. Gaging fixtures can be made interchangeable to handle various work sizes.

BENEFITS: *Lower cost per part. Gage virtually eliminates scrap by showing trend before tolerance limits are reached. Eliminates inspection errors — gage has 99.8% reliability or better as compared to about 92% for operator inspection and about 85% for inspection by other personnel.*

VARIATIONS: FEDERAL *Gages of similar type are available through machine tool manufacturers to also provide automatic compensation of the machine, either proportionally or by increments, so that drift is corrected without need for operator attention. Moral: To get the maximum return for your investment, be sure to specify* FEDERAL *Gaging when you're buying machine tools.*




INDICATING LIGHTS
INTERCHANGEABLE GAGING FIXTURES
INDICATOR SWITCHES (ELECTRICATORS)
3 OF 64 WORKPIECE SIZES FOR WHICH GAGE IS ADJUSTABLE

3 SEMI-AUTOMATIC, MULTIPLE DIMENSION MEASUREMENT

Ideal for small and medium production manufacturers, this gage checks nine dimensions in two stations and is adjustable for 64 different sizes! Work is loaded and disposed of manually. Lights show "good", "over" and "under". Units like this one have paid for themselves in well under six months.

BENEFITS: *Reduces non-productive costs — inspection time per part, in a typical case, is reduced 75%.*

Improves quality level. Inspection error is eliminated. Greatly reduced time permits profitable 100% inspection instead of sampling.

Reduces labor cost. Inspection can be performed satisfactorily by less skilled personnel.

VARIATIONS: *Unit can be designed to provide virtually any combination of dimensional measurements. Sensing elements, electrical components, housing and base are standardized. Other components designed to suit. Unit can incorporate semi-automatic disposal. Number of other design possibilities all the way up to a completely automated inspection and control gage. In every design the emphasis is on reliability. That's why, when you buy* FEDERAL *Gaging, you buy results.*

Ask **FEDERAL** *First*

FOR RECOMMENDATIONS IN MODERN GAGES . . .

Dial Indicating, Air, Electric, or Electronic — for Inspecting, Measuring, Sorting, or Automation Gaging

count human fallibility.

Fig. 1 shows a Hymatic load/unload device which is used for transferring workpieces from an overhead conveyor to a machine; returning it to the conveyor when the operation is completed. The upper view shows the device with the mechanism in the raised position and the arm ready to reach outwards and upwards to take the workpiece from the conveyor (or to put it back). The lower view shows the mechanism lowered and the arm stretched out to put in, or take out, the workpiece. The arm is fitted with an angle piece to pick up a plain cylinder but any required fittings are available. The valves, flow controller, timer and electrical relays are grouped in the control box at the base of the column. The movements are made by pneumatic cylinders controlled by solenoid valves. The timing of the movement can be signalled by the completion of the operating cycle or it can provide different lengths of dwell according to circumstances. This mechanism was used by Fisher & Ludlow in the Flowmaster punched tape controlled conveyor system which was shown for the first time at the 4th Mechanical Handling Exhibition in London last year.

Fig. 2 illustrates automatic transfer equipment which links two testing stations to lift conveyor used to carry automobile dynamos up to the painting shop. During the test a cardboard protecting sleeve has been tightened by a retaining nut and for assembly it is required that this nut shall be no more than hand-fast. To loosen the nut there is, two stations before the vertical conveyor, an automatic mechanism which grips the sleeve, sufficiently tight to prevent the shaft from turning, coupled with a power driven spanner which slackens the nut by one half turn. The clamp and spanner retract and the dynamo is indexed to the next station. Here it is picked up by gripper jaws and swung, still in the vertical position, into the path

Fig. 2—Equipment which will link two testing stations for automobile dynamos with a vertical conveyor. In addition to transferring the dynamos from a horizontal to vertical conveyor, the mechanism prepares the part for assembly by automatically loosening a retaining nut on the part to a desired fit condition.

of the upwards conveyor. This equipment is operated by air rams and is interlocked with the vertical conveyor which is the master control.

Automatic unloading devices have been designed for removing connecting rods and caps from Lumsden rotary table grinders. In one case the rods and caps are located on the side of the fixtures and held by a clamp which is common to both. This is automatically released as the fixture arrives at the unload station. Electrical contacts then operate mechanism which causes a pair of electro-magnets to move into contact with both rod and cap. The magnets with the components retract and at the full out-stroke the circuit is broken and the components fall onto a rubber-lined chute and thence onto a conveyor. The operating mechanism is composed of a single pneumatic ram fitted with a solenoid control valve.

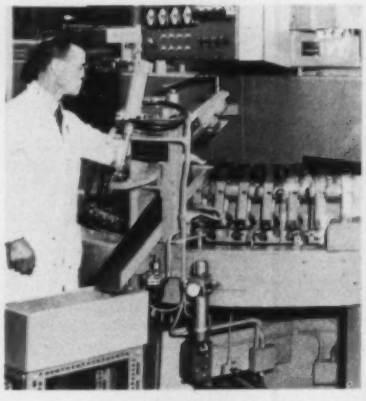


Fig. 3—Rotary table grinder is unloaded automatically by illustrated device. Electromagnetic fixture, synchronized with machine operation, picks up parts and release drops them to a rubber chute leading to a conveyor.

Fig. 3 shows an automatic take-off device for removing connecting rods after the side faces have been ground. The operating mechanism is similar to that of the previous example. The table carries a number of fixtures which hold the rods horizontally for the grinding operation. The clamp is automatically released as the unload position is reached. Then a limit switch engaged by a projection on the fixture causes a scoop to pick up the rods one by one. These are raised to an angle of 45 degrees and when released drop onto a rubber chute and so to the conveyor.

Here and There

● With the aim of advancing the latest managerial techniques of control, England's United Steel Cos. Ltd. are establishing a new central department of operational research and cybernetics. Based in Sheffield, the department will serve all branches of United Steel with advice and recommendations on operational research problems, and will provide the personnel to carry out its proposals.

It is believed that the new department will be the first in the country to make a formal study of cybernetics, the science of communication and control in the animal and the machine, which seeks to study the analogy between their structure and function. The ultimate objective of this study is to reproduce, by means of mechanical and electronic analogues, the thinking, learning and discriminating aptitudes of the human brain. Already, a number of experimental analogues have been constructed, though some considerable period is likely to elapse before full managerial use can be made of this science.

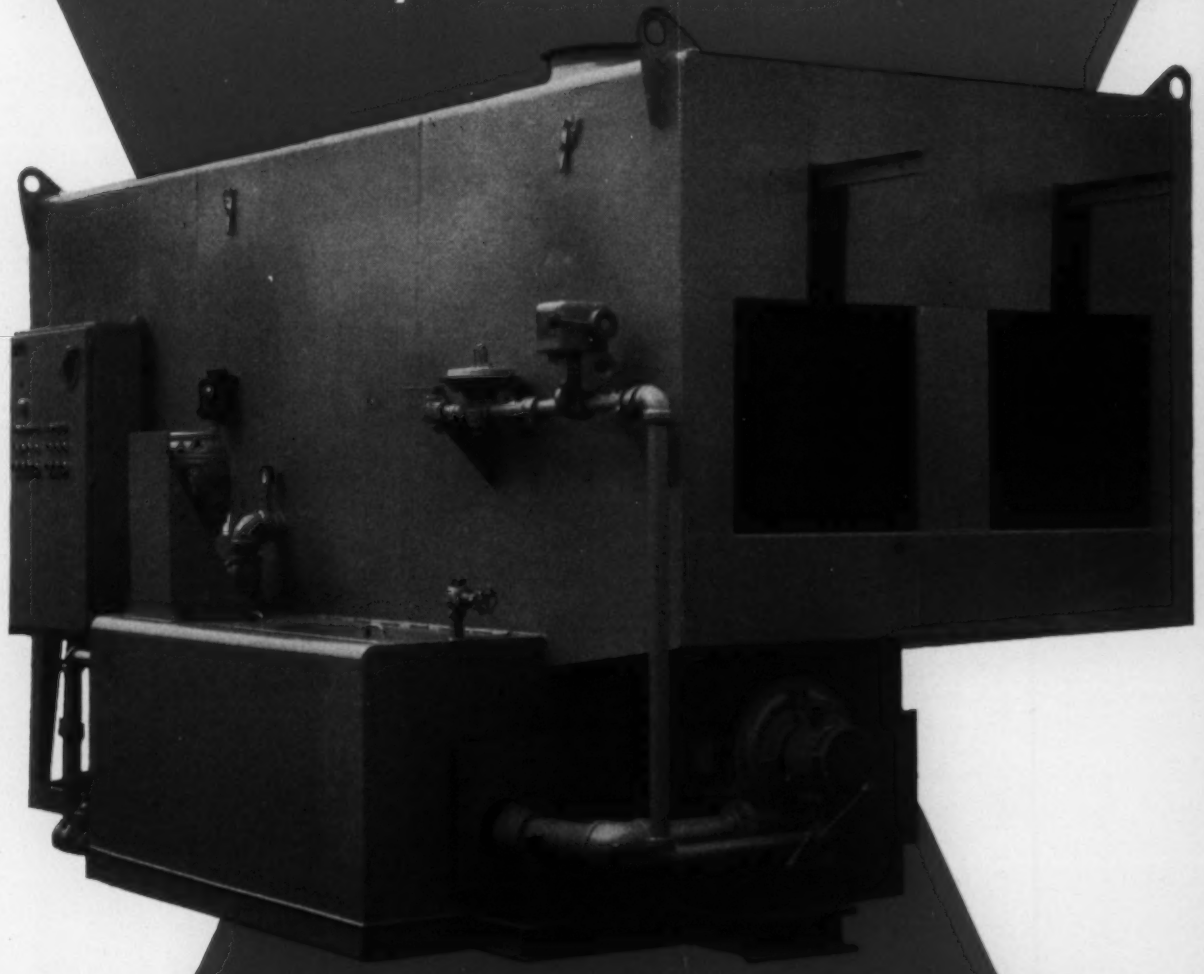
Circle 685 on Inquiry Card→

Space-Saver for . . .

2 IN 1 FINISHING OPERATIONS

Two-Pass Power Spray Washer

by PETERS-DALTON



The installation above is of a gas heated 2-Pass Power Spray Washer, designed, engineered and built by Peters-Dalton, to simultaneously accept two conveyor lines of lawn and leaf rakes. This is part of a complete P-D system. After the cleaning operations, rakes continue on their separate lines to and through dip tanks, in which each line receives a different colored paint coating. The complete P-D installation includes the 2-Pass Gas Heated Power Spray Washer, with room temperature blow-off, exhaust canopies, dip tanks and drain enclosures.

Savings effected here are obvious — not only does the washer conserve valuable plant floor space but, through the handling of two lines of parts, reduces by 50 per cent time that otherwise would be consumed in painting in separate colors.

Whatever your problems may be, you can depend, without any doubts, on the ability, service, quality and cost savings offered you by Peters-Dalton. More than a quarter century of designing, engineering, manufacturing and installing finishing equipment, of all types and sizes, assures you of finding the best and most economical way to meet your needs. Just write, wire or phone — we'll be glad to tell you more.

Representatives in Principal Cities

- *Hydro-Whirl Paint Spray Booths*
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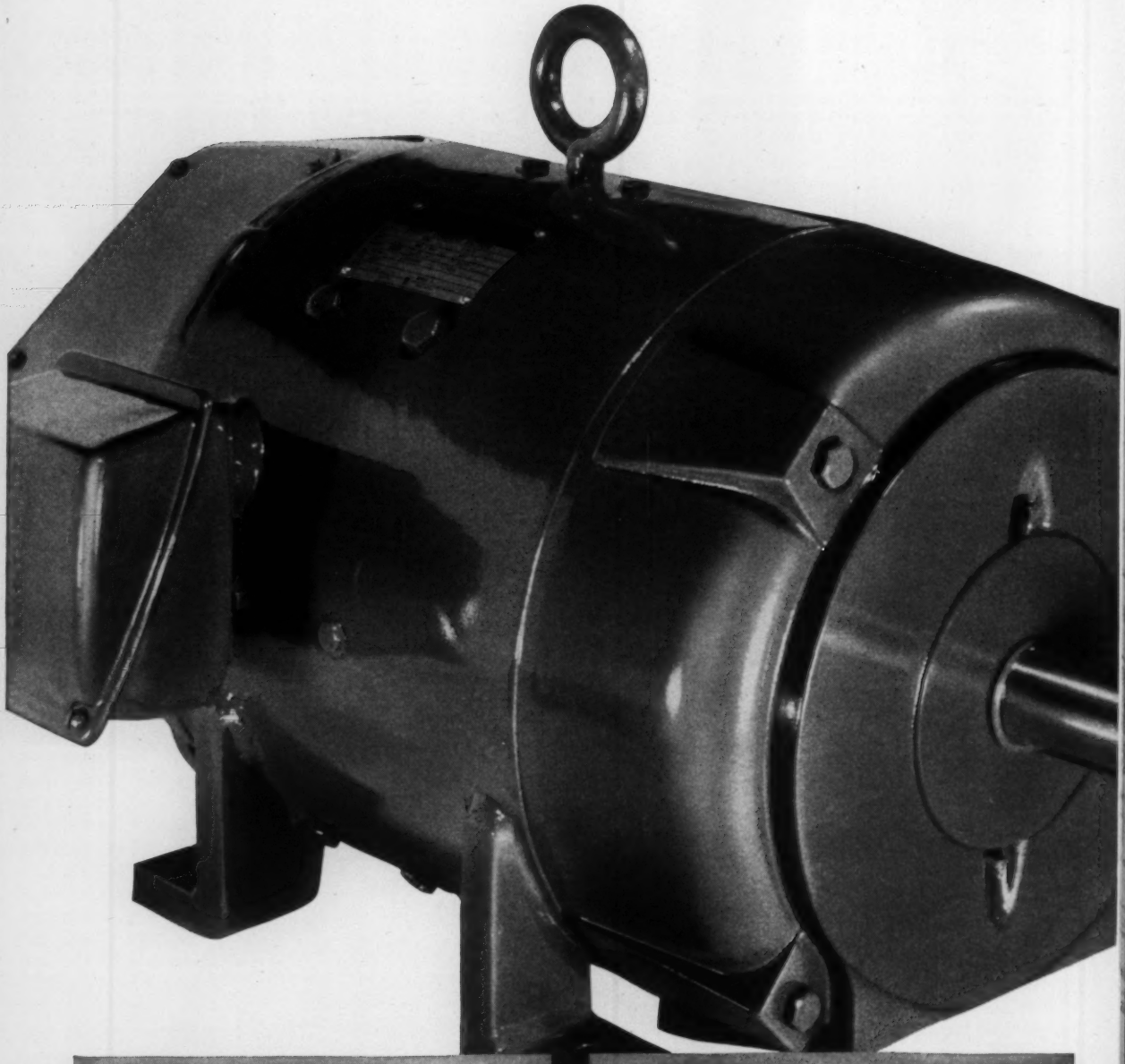
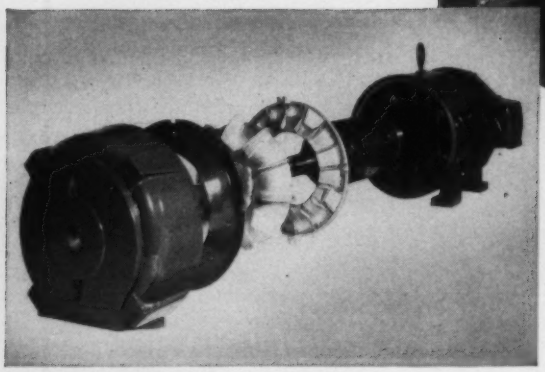
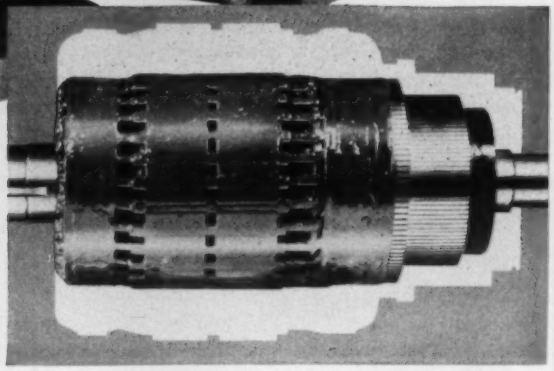




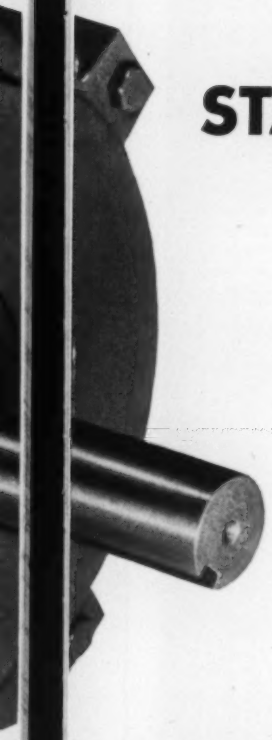
NEW CONTROLLED VENTILATION—pushes air through the motor from drive end to commutator end, opposite to the ordinary direction. Armature cooling is increased... harmful brush dust created at the commutator is blown out of the motor.



NEW LEVEL OF RESPONSE—Improved ventilation makes up to 55% lower armature inertia possible without sacrifice in capacity. Life-Line "H" gives the fastest accelerations and regulating speed changes for more and better production.

Westinghouse *Life-Line H* with silicone insulation

FASTEST RESPONSE OF ANY STANDARD INDUSTRIAL MOTOR



Life-Line® "H" Backs Up Lowest Inertia With High Commutating Ability for Increased Production

Highly responsive drives are essential to fast automatic processing. No other d-c drive provides as fast speed changes as the Westinghouse Life-Line "H".

Efficient controlled ventilation makes possible the long, slim design of the Life-Line "H" armature, reducing inertia as much as 55% without sacrificing any capacity. 35% increase in commutating ability backs up this lowest inertia to produce the fastest response available in standard industrial d-c motors today.

In addition, the new Life-Line "H" with silicone insulation, offers many dividends in long-term dependability and minimum maintenance. For all the facts about Life-Line "H" call your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa. Ask for B-7056. J-21991-C

NEW HOUSING DESIGN—provides maximum protection—eliminates need for splashproof enclosures in many cases. All access openings are sealed with covers . . . single ventilation opening in each bracket faces directly down.

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LUBRIVAL—a revolutionary new system to supply and circulate lubricating oil

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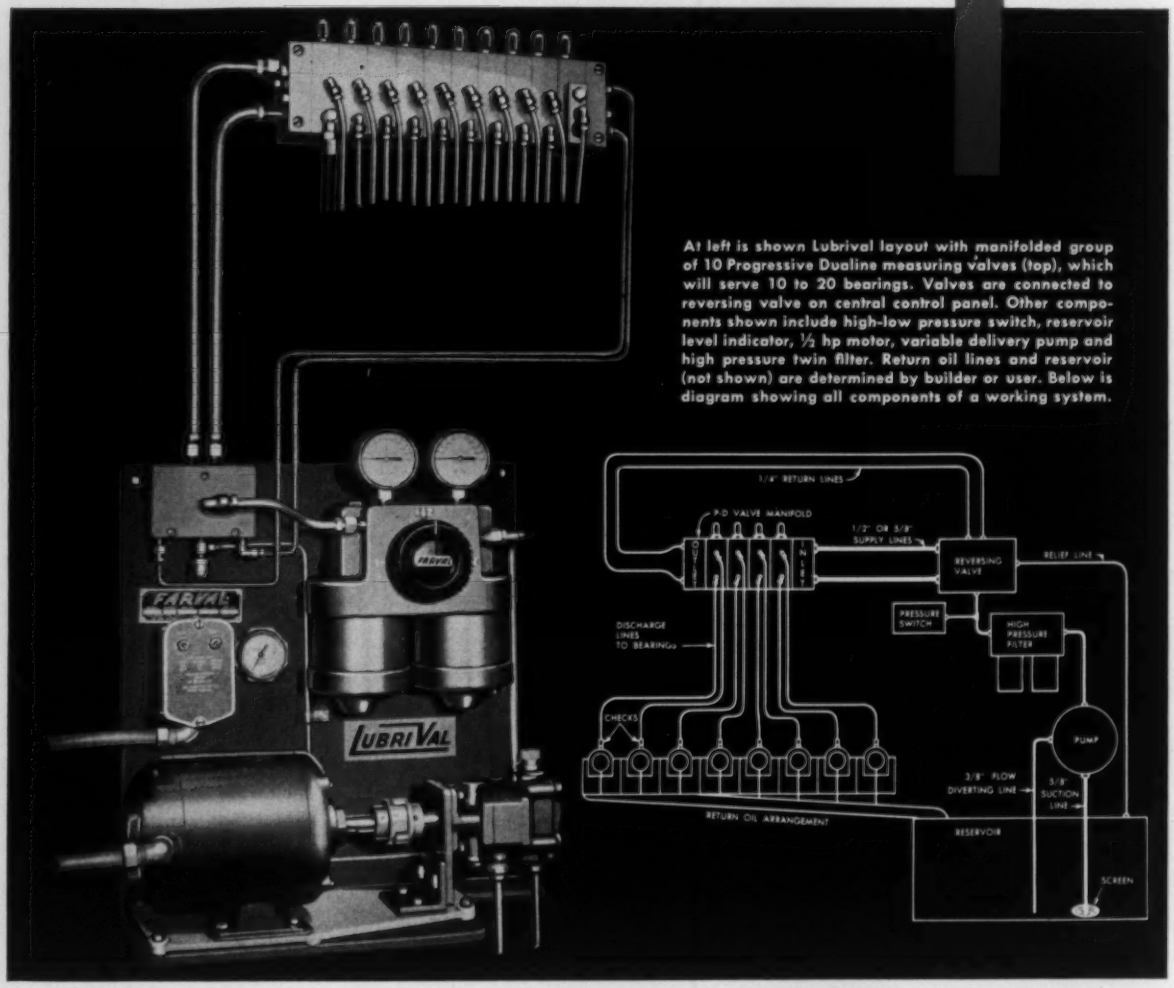
Studies in Centralized Lubrication
No. 204



At left is shown Lubrival layout with manifolded group of 10 Progressive Dualine measuring valves (top), which will serve 10 to 20 bearings. Valves are connected to reversing valve on central control panel. Other components shown include high-low pressure switch, reservoir level indicator, ½ hp motor, variable delivery pump and high pressure twin filter. Return oil lines and reservoir (not shown) are determined by builder or user. Below is diagram showing all components of a working system.

● Lubrival is designed for low volume, high pressure circulating lubrication of presses, automatic and semi-automatic machine tools and other industrial equipment designed for circulating oil systems.

Lubrival is a Farval system, employing the Dualine principle of delivering oil to measuring valves which pass it under pressure to bearings. Lubricant is force-fed by positive piston displacement. Flow can be regulated over a range of 10 ounces to 1 gallon per minute.

Lubrival Progressive Dualine Valves, manifolded in any number required, have individual sight indicators. A pressure sensing mechanism warns of clogged or broken lines in *any part* of the system—a feature entirely new to circulating oil systems.

For dependable protection of bearings and economical operation of machines, look into Lubrival. If you are a builder, offer Lubrival protection to your customers. If you use presses and machine tools, specify Lubrival on your next equipment order. The Farval representative near you will give you all details. Or write for Bulletin 70. The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

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KEYS TO ADEQUATE LUBRICATION—

Wherever you see the familiar Dualine valve manifolds, dual lubricant lines and central pumping station, you know a machine is being properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.

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Dollars, Time and Space

Who hasn't heard statements to the effect that automation is too expensive for all but the big operator, only suitable for the longest runs, too inflexible for economy in most cases? It seems to be the easy way to dismiss what appears to be a "Cadillac" approach to manufacturing. But is it?

Latest trends and experience with transfer machines plainly show the fallacy of such comment and those who indulge in it may be closing the door to opportunity. As an example, facts concerning the new Sundstrand twelve-station transfer machine built for Reliance Electric help set the record straight.

First, the machine cost 25 per cent less than the group of standard machines otherwise necessary to accomplish the same work. Second, it requires but one-fourth the factory floor space. Third, through ingenious design 36 separate motor frame parts can be processed. Fourth, setup time varies from one hour to nine hours; averages about one-tenth the total time needed for an equivalent group of separate standard machines. Fifth, and most important factor of all: as few as 40 frames per lot can be economically handled.

In addition to this highly satisfactory economic picture are the plus benefits obtained; increased accuracy, uniformity and handling efficiency. Admittedly Reliance automation engineers set their sights high, but thorough evaluation indicated their aims were well within the realm of attainment. Experience has proved the soundness of their studies.

Pertinent to their accomplishment, however, is the comment that behind the outstanding success in such a development as their new Ashtabula, Ohio, plant was full and sympathetic backing by top management. A receptive and open-minded approach to application of automation offers our greatest potential for future development in manufacturing engineering.

EDITOR

AUTOMATION

An actual case study for the manufacture of acoustic tile provides an example of procedure. The approach is not unique, but can remind the reader of points to consider in evaluating possible automation projects.

MAKING FEASIBILITY STUDIES

FOR AUTOMATION

By **E. RALPH SIMS, Jr.**, Alden E. Stilson & Associates, Ltd., Columbus, Ohio

ECONOMIC FEASIBILITY must be examined in considering nearly any industrial project. This point is at least as important to the consideration of projects dealing exclusively with automation proposals as it is to any other particular type of industrial project. In fact, it might be considered even more important in discussion of automation projects since the greatest benefits from automation often result from very broad planning involving extensive modifications or large-scale new investments in facilities.

For studyng the economic feasibility of a proposed project there are specific steps which must be taken and specific aspects which must be developed. Without a well-planned and thorough analysis, it would be difficult indeed to make any sound decision concerning the extent of economic application of automation.

This article will attempt to outline the basic procedural steps for a rational economic appraisal of automation opportunities. To add meat to the bare bones of the plan presented, a specific case study will be used to serve as an application example.

Define the Problem: *Determine the requirements and economics of partial and full automation in the*

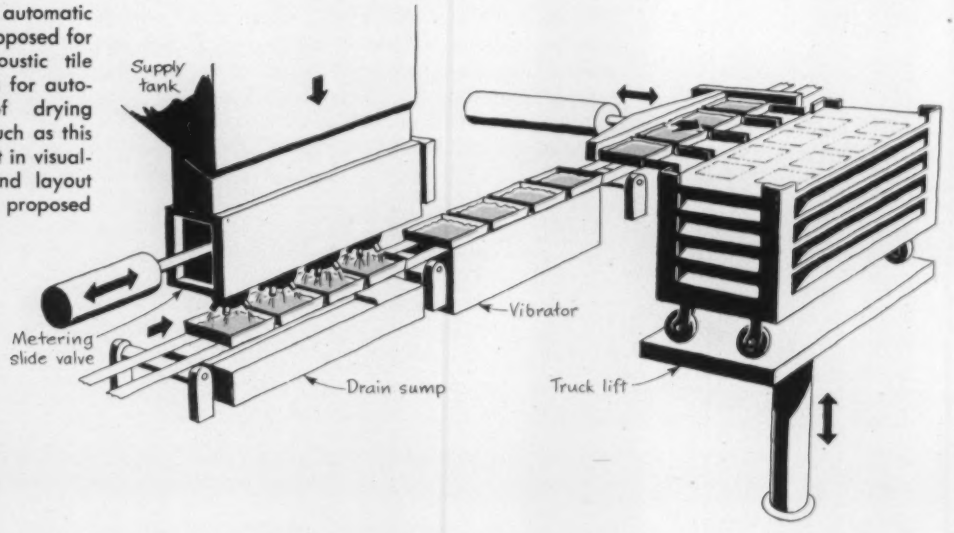


Fig. 1—Sketch of automatic casting machine proposed for an automated acoustic tile plant includes idea for automatic loading of drying trucks. Sketches such as this were made to assist in visualizing equipment and layout required for the proposed plant.

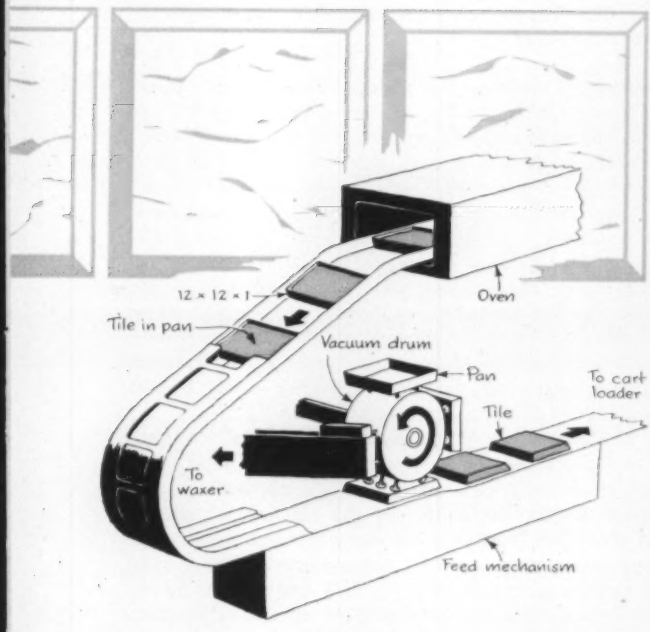


Fig. 2—Proposed machine to strip tile from pans was conceived to perform this operation automatically in line with general concept of making equipment as automatic as economically feasible.

production of a product. A manufacturer of ceramic acoustic tile, with a suitable patented process and an operating pilot plant, was faced with the problem of manufacturing for a competitive market. A decision had to be made concerning the wisdom of manufacturing the product in existing pilot plant facilities, modification of those facilities for maximum capacity or development of a fully automated plant for low-cost quantity production.

The manufacturing process involves mixing of several dry chemicals and water into a paste-like slurry which is molded and machined into a very few variations of a uniformly sized tile. All of the conditions pointed to the possibility of a high degree of automation. The raw materials could be handled with automatic machinery; the batch could be weighed automatically; the slurry could be handled automatically; the uniform product could be processed and packed automatically.

Objectives: *Appraise existing plant facilities and determine unit product cost at maximum efficiency in those facilities. Appraise increased production capabilities and cost reduction potential which might result from automation of existing facilities. Develop basic design, economics, and probable unit production costs in a new automated facility.* There appeared to be little doubt that a highly automated facility could be designed in this case.

Develop the Data: *State assumptions. Determine that the process is correct or develop an optimum process before proceeding further. Establish a production order quantity or policy upon which to base the operating plan.* At the outset, the competitive price range and required production level were unknown and awaited the findings of a market survey. In order to attack the problem, some basic assumptions were made. The product and the process were ascertained to be correct. A production level for the several styles of tile was established on a basic batch of 1000 tiles. All existing production procedures, equipment, and cost figures had been developed on this 1000-tile unit and its batching time, so the production level of the proposed plant was also calculated on this basis.

Collect the operating data. The problem was attacked in three phases. Phase I developed the cost of operations in the pilot plant. Phase II explored the production capability of a modernization of the existing facility and the effect of the modernization on unit cost at the same level of production. In this case maximum production capabilities of a modernization of the existing facility were not developed. Phase III was the development of a plan for a highly automated plant, the determination of its production capabilities, and development of new unit costs based upon automation.

Plan for the new plant was also based upon a production batch of 1000 tiles to determine the cost-reduction potential of the proposed investment. Detailed analysis and careful cost estimation were included in this phase of the study. The data was derived partly from records and partly from analysis and synthesis.

Collection of data followed the usual industrial engineering approach. A study was made of ex-

TABLE I—Manning Table—New Automated Plant[a]

	1st Shift	Rate	2nd and 3rd Shifts	Rate[b]
I. Management Group (Not Charged to Production)				
1. Superintendent				
2. Office Manager				
3. Clerks				
4. Stenographer				
II. Research Group (Not Charged to Production)				
1. Chemical Engineer				
2. Laboratory Technician				
3. Sample Maker				
III. Production Group				
1. Plant Foreman	1	1.75		
2. Shift Foreman			1	1.65
3. Finisher Operator	1	1.60	1	1.65
4. Mixer	1	1.55	1	1.60
5. Caster (2 Machines)	2	1.50	2	1.55
6. Inspector—Packing—Machine Operator	1	1.40	1	1.45
7. Stripper (2 Machines)	1	1.40	1	1.45
8. Waxer—Caster's Helper	1	1.35	1	1.40
9. Shipper—Lift-Truck Operator	1	1.40		
10. Handler—Lift-Truck Operator	1	1.40	1	1.45
11. Palletizer	1	1.30	1	1.35
12. Drying-Room Attendant	2	1.30	2	1.35
IV. Maintenance Group				
1. Operating Engineer	1	1.75		
2. Fireman			1	1.50
3. Maintenance Mechanic	1	1.65	1	1.65
4. Scrap Man—Janitor	1	1.25		
	—		—	
Groups III and IV:				
Total People by Shifts	16		14	
Hourly Labor Cost by Shifts		$23.40		$20.95
Labor Cost/1000 Tile by Shifts		7.70		6.98

(a) This is a minimum operating force, assuming peak efficiency at 85 per cent of theoretical plant capacity.
(b) Includes five-cent night bonus.

isting plant facilities. This was accomplished in concurrent steps to obtain:

1. Time standards data on existing work elements and synthesis of time standards data required but not available.
2. Inventory and sales history by item and month to develop average and peak production, storage and shipping requirements.
3. Labor and overhead cost data to develop and evaluate proposals.
4. Organization data with job descriptions and pay grades.
5. Flow process charts of existing operations.
6. Plant layout information and templates of existing equipment.

Analyze the Data: The data was scrutinized to detect inefficiencies and develop cost reduction objectives. Operating data was converted for use in the development of improved methods. Finally the data was interpreted and evaluated with relation to company policy to determine planning criteria such as inventory level, sales quotas, operating hours, work schedules, organizational structure, etc.

TABLE II—Equipment—Cost Summary—New Automated Plant

	Installed Cost	Depreciation	
I. Car-Unloading Systems ...	$ 10,750.00	10%..	$ 1,075.00
II. Bulk-Storage Equipment ...	16,650.00	10%..	1,665.00
III. Feed Systems	26,528.00	20%..	5,306.00
IV. Batch-Mixer Installation ..	10,800.00	20%..	2,160.00
V. Casting System	137,140.00	20%..	27,428.00
VI. Finishing Equipment	29,000.00	20%..	5,800.00
VII. Packing Machinery	69,800.00	20%..	13,960.00
VIII. Handling Equipment	97,987.00	20%..	19,598.00
Total for Equipment	$398,655.00		
15% for Contingency	59,798.00	20%..	11,960.00
Total Allocation for Equipment	$458,453.00		
Annual Cost of Equipment.			$88,952.00

Note: Engineering fees not included.

Develop Philosophy of Operation and the Concept of the New Facilities: *Develop the overall system.* The data were analyzed and process flow charts made. Template boards and grid layouts were used to study possible plant layouts. Each trial layout was tested by applying an overlay flow chart. After the most desirable template layout was developed into a practical operation, final process flow charts were drawn and detailed layouts were prepared.

The layout and its component details were subjected to criticism by operating personnel Cost estimates were developed for each component of the installation, and an overall investment cost was calculated.

Develop automation equipment requirements—operating characteristics, basic design, production capabilities, cost estimate. In order to develop the basic mechanisms which would be necessary to streamline the process, each phase of the operation was scrutinized for repetitive procedures which could be performed automatically. These procedures were extracted from the process and studied independently to develop principles upon which machinery could be built.

Mechanization of production processes requires careful engineering and long range investment. The layout of any new plant facility necessarily depends on the feasibility of the mechanical equipment. The feasibility of the proposed mechancal equipment was carefully investigated. Schematic drawings shown in *Figs.* 1, 2, 3 and 4 were made to demonstrate the principles of operation applied to the proposed mechanical equipment.

Develop packaging and handling requirements—operating characteristics, basic design, production capabilities, cost estimate. The handling system for incoming raw material was designed for bulk delivery and movement of the primary components. An automatic batch-weighing system consisting of rotary bin valves, scales, and vibrating feeders was planned to deliver the dry products from storage hoppers to the batch mixer by means of a zipper-type conveyor. The liquid components were to be delivered to the mixing tank by pipe.

All of the supply equipment (hoppers, feeders, conveyors, mixing system, etc.) was designed to be remotely operated by one operator from a central panel. The operator would maintain control at all times, being able to stop and start the system and make adjustments at his discretion. However, once the system was set up, the whole feeding operation could be started and automatically continued step by step until the batch was complete in the mixer.

A valve, using a principle found in canneries handling viscous products, was developed to slice a volumetric measure of the batter from the feed line and drop it into the casting funnel. The casting machine, shown schematically in *Fig.* 1, would fill four casting pans at each cycle, and the pans automatically would be loaded on drying trucks.

The success of the mechanization would depend upon a flushing system cycled into the operation. After each mixer batch, a hot flush would automatically clear the system, washing the mixer, secondary mix tank, casting tanks and casting machine. It was assumed that a 1000-tile batch could be mixed every 20 minutes. The production capacity would be 3000 tiles per hour for the plant.

A mechanical stripping machine, *Fig.* 2, would be installed at the output end of the casting oven. It

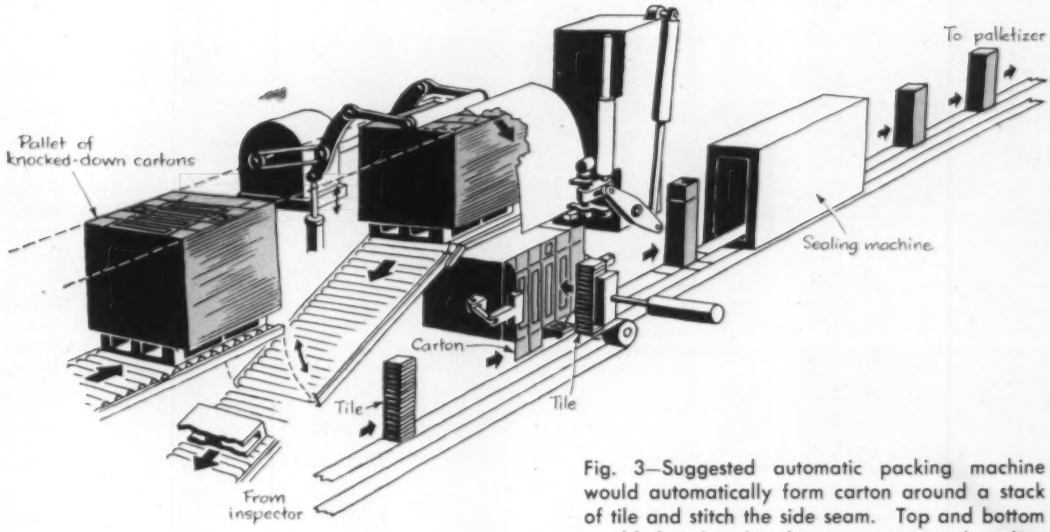


Fig. 3—Suggested automatic packing machine would automatically form carton around a stack of tile and stitch the side seam. Top and bottom would then be closed in a conventional sealing machine.

would automatically remove the pans from the tile and place them on a conveyor to be returned to the waxing machine.

From the stripping machine, the tile would be fed automatically into a truck-loading machine, similar to that which appears in *Fig.* 1. At this point, the drying trucks would be loaded automatically. The trucks would be placed in the drying room as scheduling required.

One of the most costly operations in any plant, and one which is usually subjected to a great deal of scrutiny, is the packing of the finished product. *Fig.* 3 shows a schematic drawing of a packing machine designed to handle and pack stacks of tile. This machine would take a specially designed knocked-down carton from a pallet, wrap the carton around the stack of tile, staple it down one side, and then feed it into a sealer which would close the ends. The empty pallet would automatically be replaced by a loaded one. The package would be conveyed to a palletizing station or pallet loading machine. Calculations indicated that a pallet loading machine would pay for itself in approximately three years on a three-shift operation.

Develop the general arrangement layout and building outlines. The future plant operation was planned on a functional basis to determine the equipment necessary to each stage. Where the flow is not straight, mechanical and bulk handling equipment reduces labor. Time-and-place utility was a paramount consideration in laying out the operation.

After the operating equipment layout was completed, a building was designed around it, *Fig.* 4. The building was designed functionally, with attention to the aesthetic values.

Estimate the Costs: *Develop a cost estimate for all equipment and the building. Prepare manpower*

TABLE III—Building-Cost Estimate—New Automated Plant

I. Structure		
A. Land	3¾ acres with railroad siding 400′ x 400′ lots to allow expansion	$ 22,500
B. Building	130′ x 330′ building—steel truss and precast slab roof—65′ spans, 50′ at 40′ clear height—180′ at 14′ clear-height, block walls and brick faced on front and corner only, 8″ concrete floor—pits, but no cellar; includes sewage, plumbing, toilets, offices, windows, painting, grading, and rolling doors—42,900 sq ft at $7/sq ft	300,000
II. Services		
A. Lighting	General factory lighting, including office — 42,900 sq ft	19,500
B. Power Supply	Assuming 13,200-volt primary pole, service, transformers, and bus duct	6,500
C. Heating System	216,000 Btu-3R-1 boiler with burners—gas fired, 280-gal/hr hot-water coils and installations	2,750
	10 steam-heated space heaters—installed	4,000
	10 steam radiators—installed	850
D. Compressed-Air System	Installed	10,000
E. Telephone Service	Installed—5 stations	1,000
F. Fire Protection	10 CO_2 extinguishers, 8-15 lb units	440
	2-75 lb units	250
	6 hose stations—installed	3,400
III. Special Items		
A. Railroad Unloading Pits		10,000
B. Outside Paving, 25,900 sq ft at $1/sq ft		25,900
C. Incidentals—Pits—Floor plates		3,000
Total Cost for building and grounds		$410,090
Contingency 15 per cent		61,513
Total Building Allocation		$471,603
Depreciation at 5 per cent annum, Annual cost		23,580

Note: Engineering fees not included.

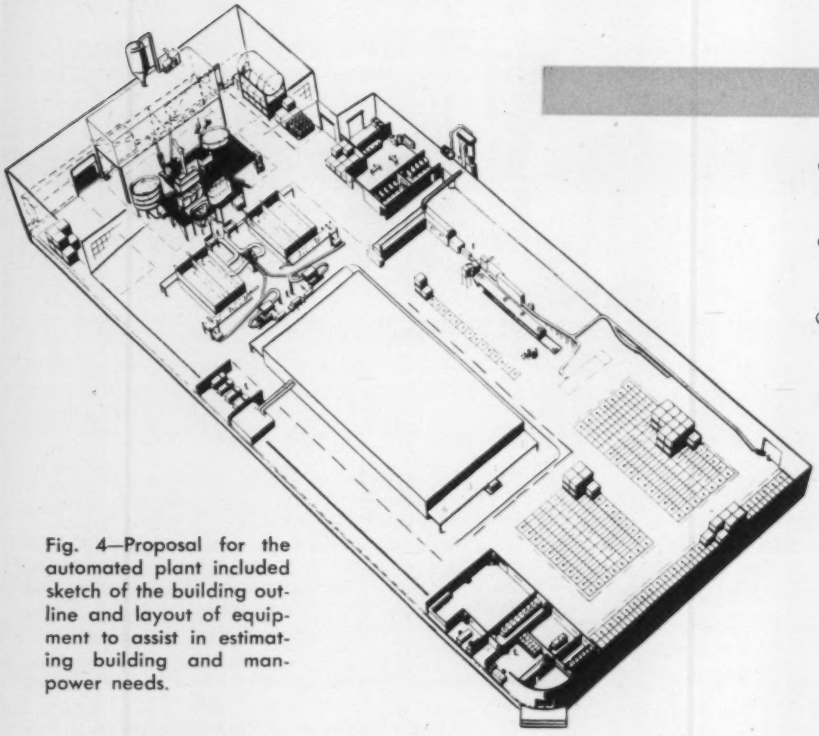


Fig. 4—Proposal for the automated plant included sketch of the building outline and layout of equipment to assist in estimating building and manpower needs.

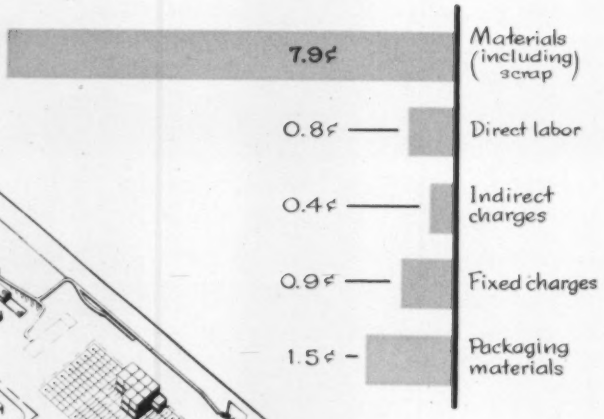


Fig. 5—Graphic breakdown of estimated costs for production of acoustic tile in proposed plant.

plan (organization structure, manning table, wage and salary structure, and personnel cost estimate). Estimate fixed charges and overhead costs. The data required for the plant layout development included materials information, labor information, and operating procedures. Material costs of $67.16 per thousand tiles were developed from raw material information and prices. Scrap loss was estimated at $11.17 per thousand tiles.

Time-study standards and machine rates were applied to the various operations in each layout and the labor requirements were synthesized. Labor-

TABLE IV—Annual Production—Cost Summary—New Automated Plant

	One Shift	Two Shifts	Three Shifts
I. Fixed Charges			
A. Building and grounds	$ 23,500	$ 23,500	$ 23,500
Fire insurance	1,600	1,600	1,600
Property taxes	4,000	4,000	4,000
B. Equipment costs	88,952	88,952	88,952
Fire insurance	2,250	2,250	2,250
II. Direct Charges			
A. Production labor	36,000	70,176	104,352
B. Benefits			
1. Vacations and holidays	200	345	480
2. Compensation and insurance	864	1,564	2,264
C. Materials (at present scrap rate)	386,000	735,000	1,064,000
D. Packaging materials	79,300	150,600	218,000
III. Indirect Charges			
A. Maintenance labor	8,930	15,980	22,030
B. Miscellaneous	5,000	6,500	8,000
IV. Power	5,800	10,600	15,400
Total Annual Cost	$642,416	$1,111,067	$1,554,828
Total Annual Production Capacity (theoretical)*	5,750,000 tile	10,930,000 tile	15,830,000 tile
Production Cost per Tile (theoretical)	$ 0.112	$ 0.102	$ 0.098
Probable Annual Production (85%)*	4,400,000	9,300,000	13,500,000
Probable Cost per Tile (at present scrap rate)	0.146	0.119	0.115

*—Calculations allow 10% production loss on second shift for two-shift operation, and 15% production loss on third shift for three-shift operation.

Note: Engineering fees not included. Operating capital not included. Figures assume plant to be well broken in.

TABLE V—Summary of Alternatives

	Existing Plant Operation	Modified Plant Operation	New Automated Plant Operation
Assumed Maximum Annual Production	3,540,000[b]	3,540,000[b]	15,830,000
Estimated Investment	.....[c]	$ 23,825.00[c]	$ 930,056.00
Estimated Annual Operating Cost	$523,290.00[c]	$494,210.00[c]	$1,554,828.00
Theoretical Unit Cost	$ 0.150	$ 0.140	$ 0.098
Probable Unit Cost	Varies 0.16-0.18	0.140	0.115[a]
Probable Annual Savings in Product Cost[a]	.....	$ 35,400.00	$ 554,050.00
Months to Recover Investment	.....	8½ months	21 months
Years to Recover Investment	.....	2/3 year	1¾ year

Note: This table assumes no change in the process. Engineering fees are not included in the estimates of investments.
(a) Does not include potential savings by reduction in scrap losses.
(b) Production figures based on the assumption that July, 1952, rates can be maintained throughout 12 months.
(c) Based on the assumption that the finishing machine would operate satisfactorily on a two-shift basis. No funds included for overhaul or replacement of the machine.

cost figures, TABLE I, were developed from the synthetic labor requirements.

The estimated material and labor cost and the annual cost of the investment for each phase of the study combined to develop the investment and product cost figures by which the alternative plans could be evaluated. The investment cost for this installation was based on the figures summarized in TABLES II and III.

Convert Cost Data Into Unit Production Costs: *Develop unit costs for various levels of production, and for present and possible future facilities.* The annual production cost summary is shown in TABLE IV. Technical, sales, delivery and office administrative costs are not included in these figures. This annual cost summary shows one, two and three-shift production levels and the anticipated product cost and operating expense. Using the information in TABLE IV and that developed earlier, TABLE V was prepared to compare the alternatives.

Evaluate the Unit Production Costs: *Study market data and develop market economics of program.* Scrap loss resulting from machine error, mixing error, curing cracks, handling damage, etc., is one of the main cost problems in the production of this tile. It was not possible, on the basis of the information available, to estimate the improvement in scrap loss. However, better quantitative control can be anticipated with automatic measuring equipment, and improved finishing machine operation would reduce scrap at that stage. The mixing or curing error scrap could be reduced by improved supervision. Calculations indicate approximately 1.1 cents per tile in scrap cost, based upon past figures.

Although the proposed plant can achieve a theoretical unit cost of 9.8 cents, a realistic adjustment of these figures indicated a probable production cost of 11.5 cents per tile at 13,500,000 tile per year output. The capital investment upon which this figure is based does not include engineering costs or working capital.

The anticipated unit cost of tile at full production in the proposed plant, 11.5 cents, is composed of costs shown in *Fig.* 5, where the material cost includes scrap but does not include supplies for maintenance.

Make a Decision: With the facts developed in this manner, plus other material at its disposal, management is better able to make wise decisions on future courses of action. Only by such thorough study can the most economic level of automatic operations be suitably determined for effective long-range planning.

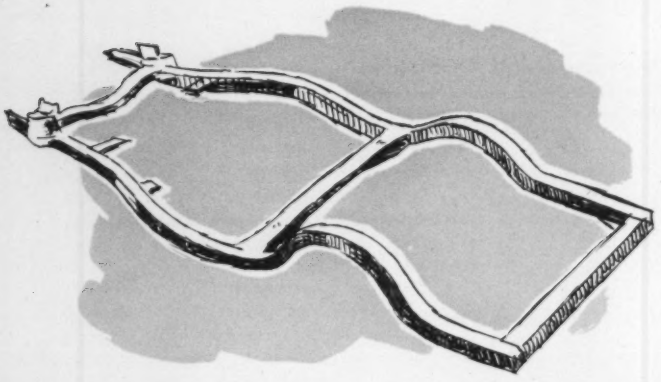
Transcribing Card Data

PUNCHED card transcriber developed by the National Bureau of Standards reads from 200 to 600 cards per minute and converts punched data into a binary serial code. Output of the unit may be fed directly into a high speed computer or stored as a magnetic recording.

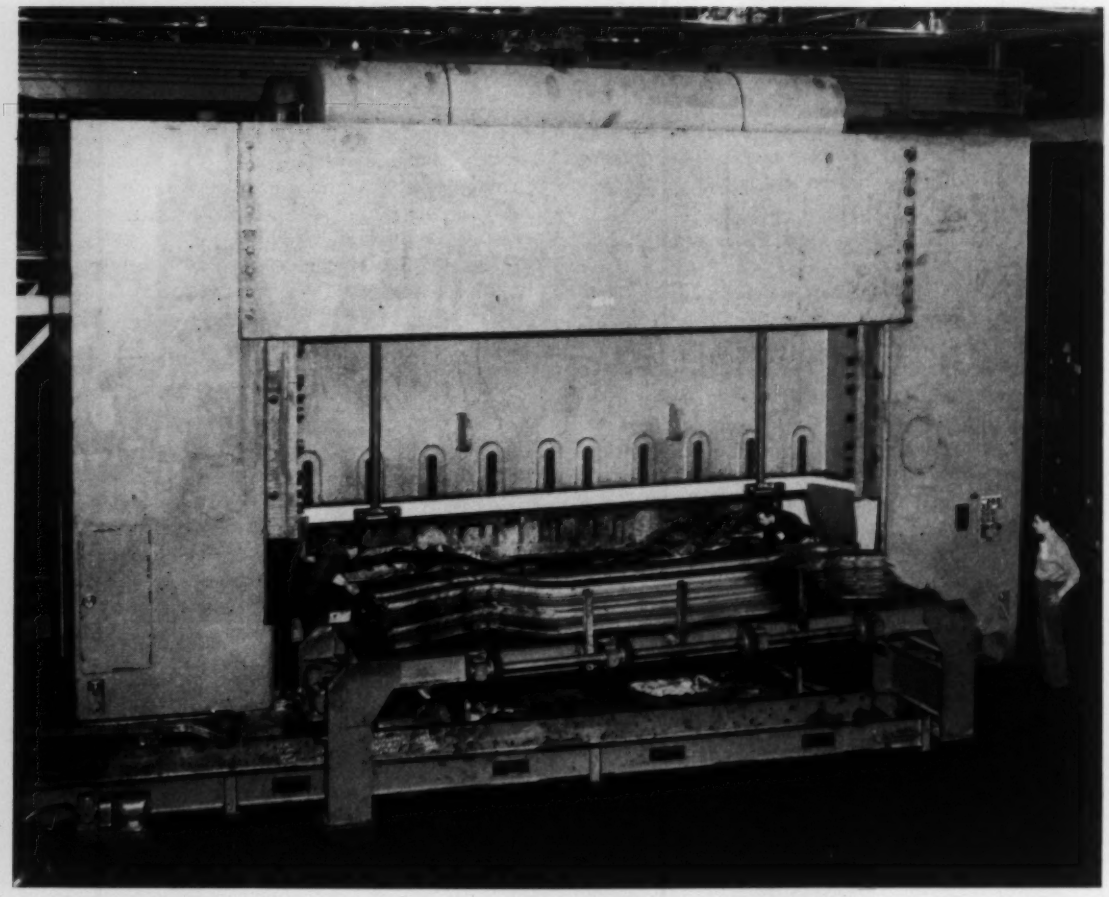
The transcriber serially scans the 80 columns on each card with photoelectric cells and converts the data, one column at a time, into voltages in 14 different information channels. Twelve of the channels are for direct information transmittal and two for control purposes. Pulses in the 12 information channels are fed into a gating matrix whose output is a 6-bit binary code.

Timing circuits are keyed to a strobe pulse initiated by the leading edge of each punched column. This means that card flow need not be synchronous nor data flow continuous.

A self-inhibiting feature allows entire fields of information to be ignored by the sensing circuits. Descriptive information as well as computer data can thus be punched on the same card, but only desired data will be transcribed.



AUTOMATION TODAY



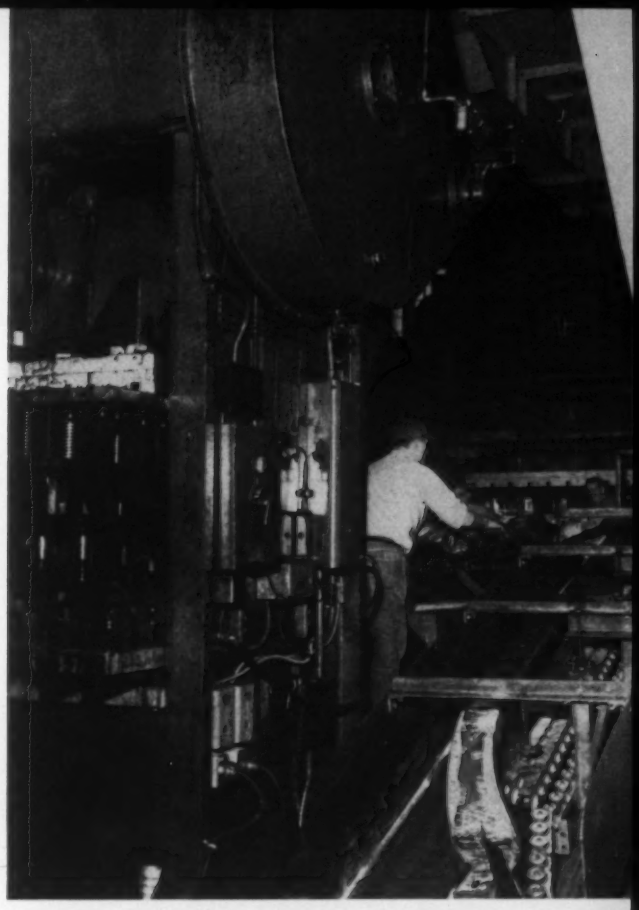
1 Bliss 2400-ton underdrive press forms left and right chassis frame siderails simultaneously. Blanks are removed from piles by the two operators shown and placed in the die. Two operators on the other side of the press perform the same operations for the rail of the opposite hand. After both blanks are loaded the press strokes and the formed rails are placed in the conveyors under the operators' loading tables. This 40-foot long press is the largest ever built using the underdrive principle. This permits locating overhead crane rails at a height where crane efficiency can be retained, and also provides easier maintenance accessibility.

NEW AUTO FRAME LINE

ITS CHASSIS FRAME may not be the most glamorous part of today's sleek automobile, but few will argue that the frame is not one of the most important components of a modern, high-powered motor car. Inherent strength and ruggedness is a prime essential in chassis frame design and manufacture. Therefore production processes must be sound and technically well-grounded.

To keep abreast of an evergrowing demand for its products Dana Corp.'s Parish Div. has completed a multimillion dollar expansion program representing a 40 per cent increase in frame plant capacity.

Housed in two new bays, totalling 185,000 square feet in area and featuring two-floor construction, are completely new production lines for the manufacture of Buick "Special" and Mercury chassis frames. The Parish Div. has produced Buick, Oldsmobile, and Pontiac frames for General Motors, but the manufacture of these components for Mercury is brand new to it.

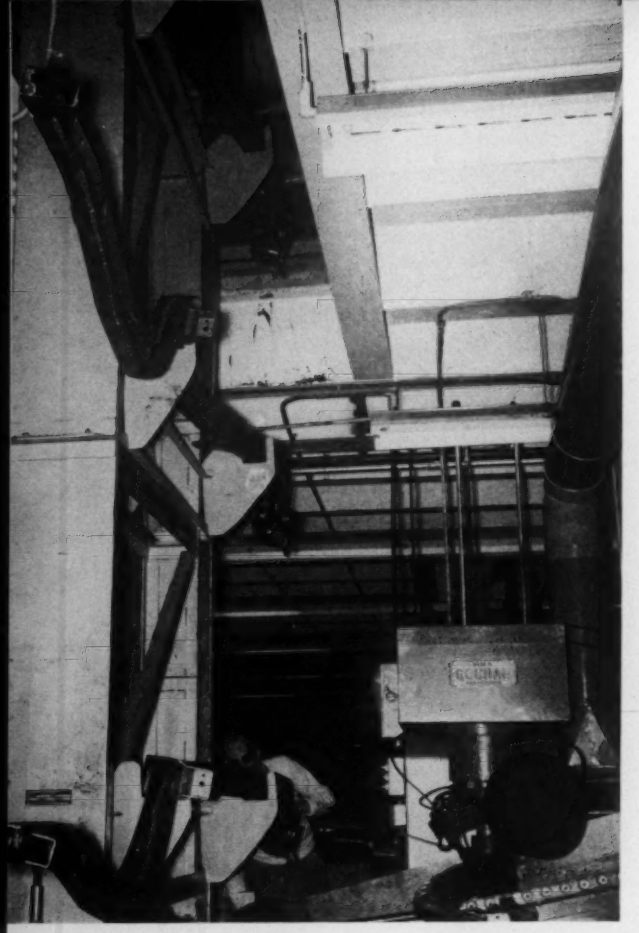


2 After the underdrive press operation, the siderails travel by flat conveyor to a bank of smaller presses equipped with side-action perforating tools. Here perforating necessary to assembly is done. Perforated rails are routed to the basement and deposited on another flat conveyor which serves also as a banking device with capacity to hold an entire shift's production.

Not only is Mercury a new customer, but the frames for these cars represent a considerable departure in design, both for the car manufacturer and the frame builder. The new frame is of the "box-section" type, and poses some rather unusual problems in welding (for components of its type) as well as in general fabrication.

To meet these problems, as well as to bring about a general technological improvement in its as-

3 In subsequent operations body brackets and reinforcing plates are riveted and welded to the siderails; inner and outer side bar members are welded together by manual metallic inert gas shielded guns; front spring seats and upper suspension control arm brackets are then riveted into position. This assembly is then positioned in the automatic welding machine shown here and the front spring seat is welded circumferentially using the metallic inert gas shielded process.



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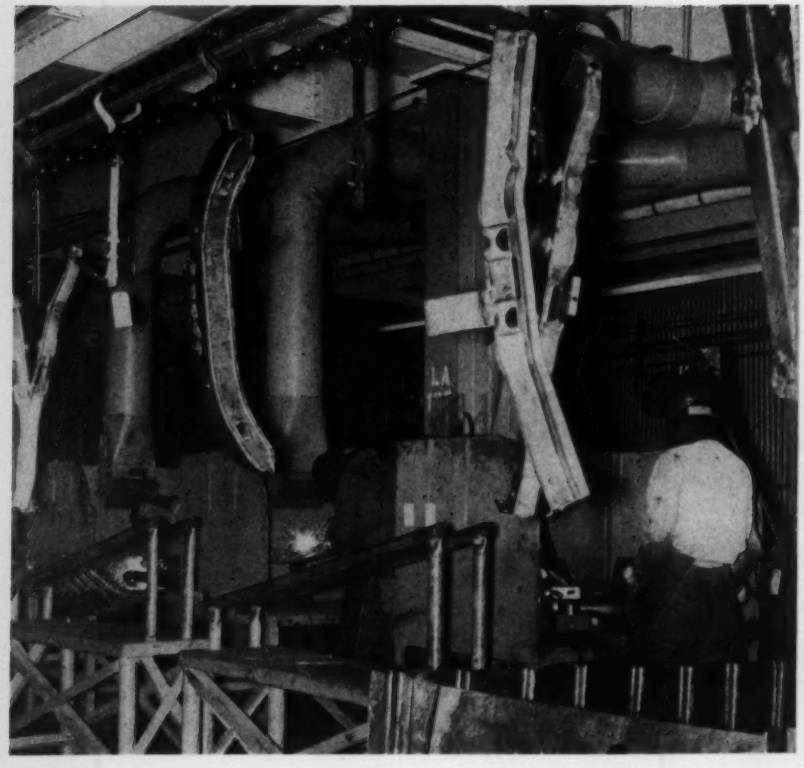
After the automatic circumferential welding operation, siderails are routed to the first floor on the special elevator shown at the left of this picture.

sembly techniques as applied to all of its frame fabrication, a feature of the new addition is the widespread use of the metallic inert gas (CO_2) shielded welding process, which Parish engineers have succeeded in substantially speeding up and applying to the extensive welds inherent in Mercury frame production. This welding technique is in use at the plant on both an automated and manual basis.

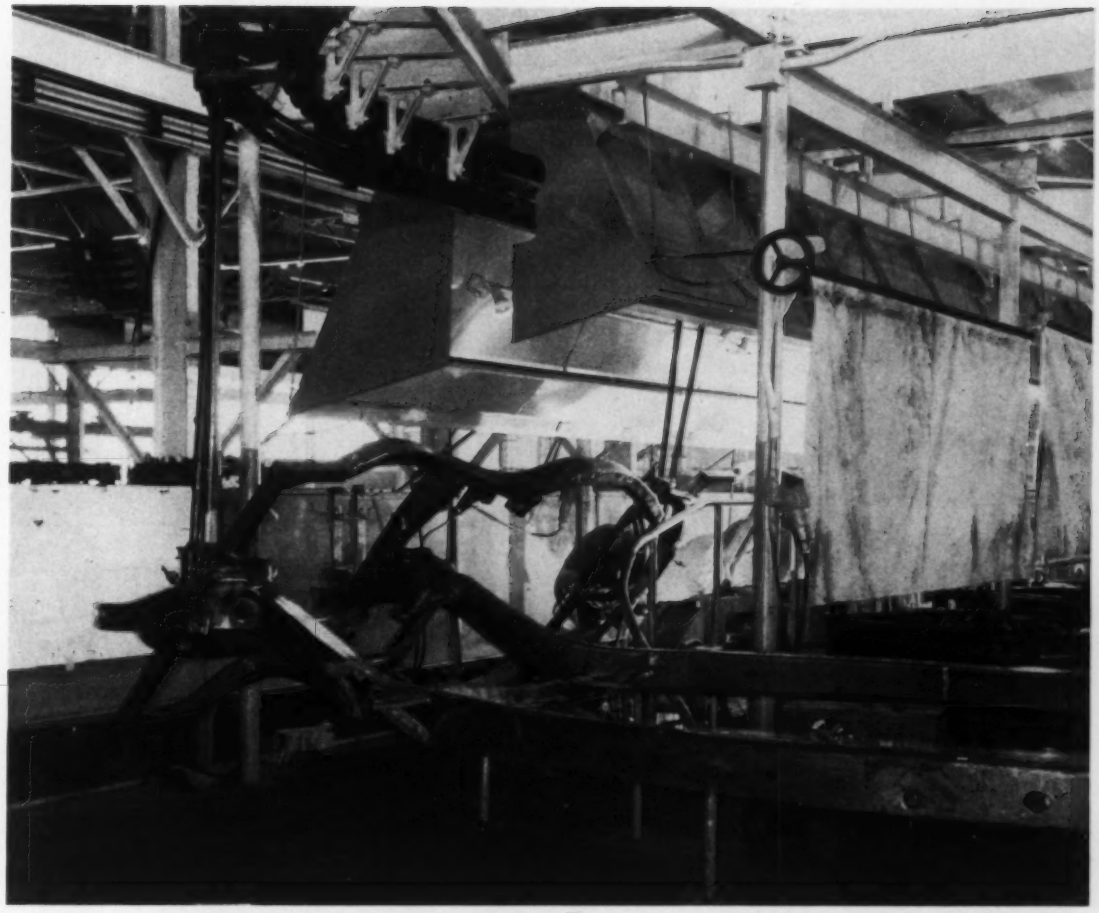
Coupled with this development, to help make the automobile frame plant a more efficient operation today, are a series of Dana-designed special production aids and features to be found on the assembly lines themselves, plus the attainment of good material flow in what normally is not the most efficient type of plant design—two-floor construction.

Accompanying photographs provide a graphic tour of the Mercury line at the Parish Div., and highlight the automated material handling techniques employed to ensure efficient material flow between the two floors of the new addition.

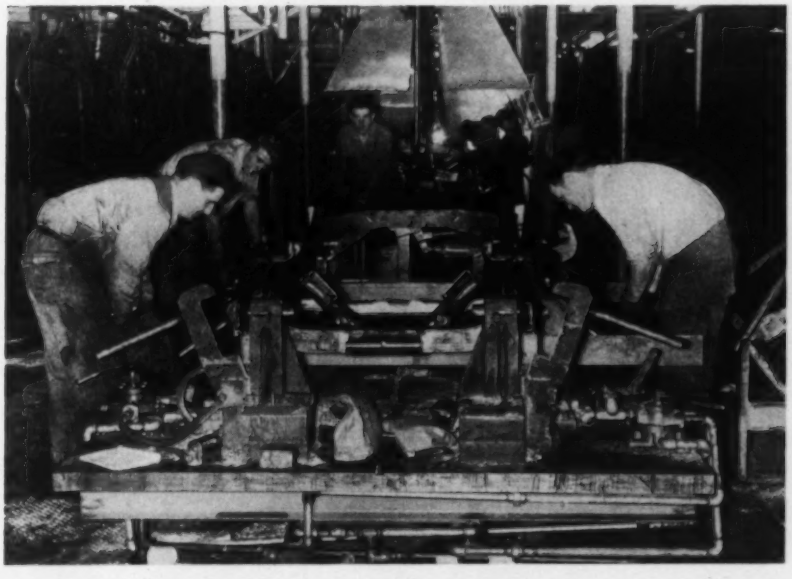


5

Cross-member subassemblies are welded in the basement in an area adjacent to the sidebar subassembly location. These smaller subassemblies are elevated to the final assembly line on the first floor by means of a monorail parts conveyor.



6 On the first floor siderail and crossmember subassemblies are brought together in an assembly fixture and are hooked into hangers on an overhead trolley conveyor system that carries the frames through successive operations of the final assembly line. These hangers have pivot points at their lower extremities to enable the frames to be inverted for welding on the underside.



7 After inspection and repair welding, the frame is then positioned in a straightening fixture where body bracket and bumper hole elevations are closely checked. On completion of this step, the frame is then conveyed automatically into a paint shop where it is washed, painted through use of a flow-coat method, then baked dry. From the paint machine, the frames go directly into railroad cars for shipment.

AUTOMATIC TESTING

IN TELEPHONE MANUFACTURE

Once again we find the necessity for co-ordination of various industrial disciplines in order to successfully wrestle with application of automation to what was once considered an isolated specialty—inspection. This point is made by an author who has a long record of applying automation techniques to testing in the communications field. As he says, "Boundaries of the specialists' domains are readily crossed."

By **D. T. ROBB**, Engineer, Transmission Test Set Development, Kearny Works, Western Electric Co., Kearny, N. J.

MANY ITEMS used in the telephone system are manufactured in such numbers that automatic shop testing of them is desirable. The cost of manual testing by suitable personnel is high, and the work so repetitive and dull that accuracy suffers. Fortunately, in many cases the complexity of the test requirements has matched the state of the art and the business picture well enough to warrant the development of machine methods. It is the purpose of this article to review the art as it has evolved in the Manufacturing Div. of the Western Electric Co., and to describe some of the techniques. This is done with the hope that improvements or extensions to other testing or manufacturing problems may be suggested.

Developments treated herein have required cooperation among testing and manufacturing engineers in Western and product-design engineers in the Bell Telephone Laboratories. Modifications of design for Western's convenience, changed methods for translating basic requirements into manufacturing test requirements, informal Laboratories suggestions of approaches to manufacturing and testing problems, all are commonplace. The boundaries of the specialists' domains are readily crossed.

Based on an article published in *The Bell System Technical Journal*, September 1956.

Testing is a process for proving something—such as quality of a product or accuracy of a computation. In one form or another, testing is essential in manufacture. It insures against further investment of effort in product found bad. It provides information for the manual or automatic correction of earlier processes to prevent manufacture of additional faulty product. Also, its techniques and devices are used in many applications where testing is not the object. TABLE 1 gives a listing of functions, with examples of some of our automatic means, that illustrates this. Of these Functions 1*a*, 4, and 5*a* are testing functions. The remainder are manufacturing processes.

Fundamental steps necessary to any testing operation are:

1. Placing the item to be tested in location.
2. Subjecting the item to a specified set of conditions.
3. Observing the reaction of the item to the test conditions.
4. Comparing the observed results to required results.
5. Deciding on the basis of the comparison what disposition to make of the item.
6. Indicating the disposition.
7. Making the disposition. (This may mean transportation, repair or adjustment.)

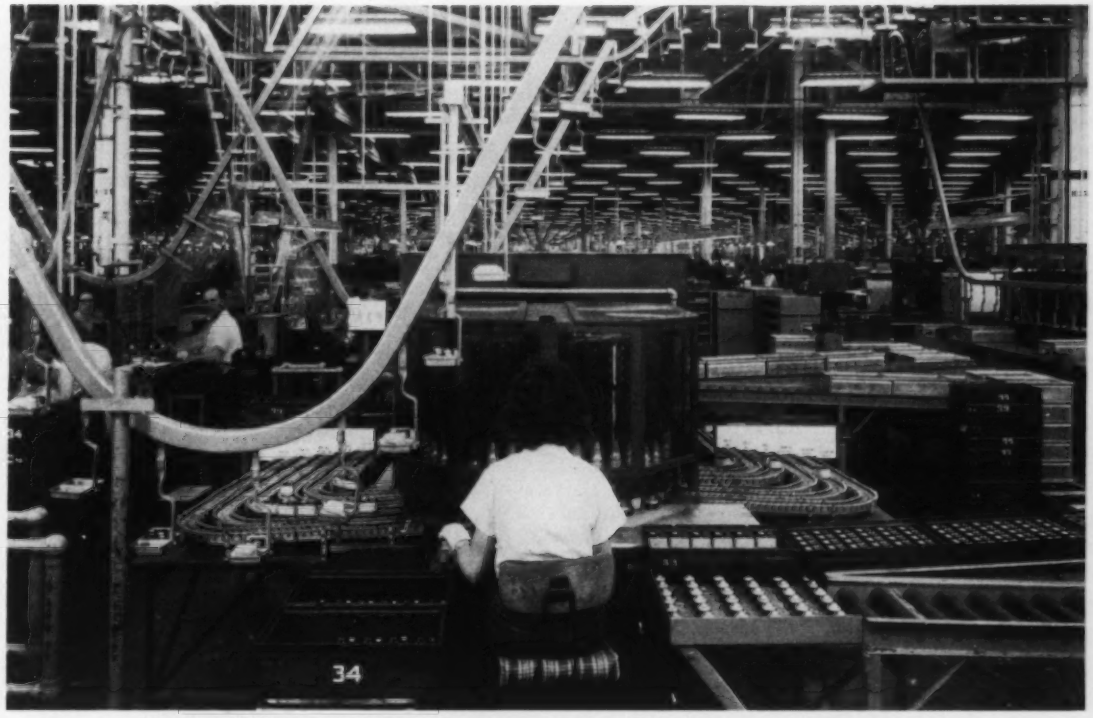


Fig. 1—Network testing machine used in the manufacture of telephone sets. Rotation of the turret presents the operator with an empty test fixture every 3¾-seconds. Good networks, ejected automatically into a roller chute at the left, are hand loaded into carriage fixtures of the overhead storage conveyor. Twelve roller conveyors for rejected networks of each test category are arranged along the sides of the machine.

In purely manual testing all of these steps would be initiated by human operators. In many cases it is feasible for all steps to be taken automatically. The bulk of our accomplishment in automatic testing, however, has been in steps 2 through 6.

▸ Build on Experience

Present models of many of our machines have evolved from earlier models, either because of changed product or test requirements or through improved designs worked out for plant expansion or cost reduction. About 1927 there were put in use at the Hawthorne Works, Chicago, two machines, one for gaging a number of critical dimensions and performing a breakdown test on carbon protector blocks, and the other for heat coils. In the protector-block machine the blocks follow a linear course drawn by an indexing chain conveyor through a number of positions where the various checks are performed. Failure of any block at a position causes a jet of air to blow the block into the opening of a chute which conducts it to a reject pan. Good blocks are delivered into a pan at the end of the run. The heat coil machine has an indexing turret over a ring of ports which open selectively to permit good or rejected coils to fall into chutes. The test parameters are three gaged dimensions and dc resistance.

In 1929 a machine with an indexing turret was put in use, testing paper capacitors for dielectric strength and leakage resistance and sorting them into 13 cells for capacitance grouped around a nominal 1 μf. The 13 cells correspond to 13 segments in a commutator disposed along the scale of a microfarad meter. For a given test capacitor, when the meter needle reaches its deflection a bow depresses it against the nearest segment, establishing a circuit through a relay. A system of relays then locks and serves as a memory to operate a solenoid later when the turret has brought the capacitor to the point of disposition. Action of the proper solenoid causes the capacitor to be deposited in its cell. The cells are arranged as parallel files in a horizontal plane and, starting with the cells empty, the machine will in effect produce a "stovepipe" distribution curve. Capacitors from the middle cell and its upper neighbors may be used as 1-μf capacitors, and those from more remote cells combined, large with small, to make 2-μf capacitors.

Also in 1929 a turret type machine was used for sorting mica laminations. The sorting parameter was ac dielectric strength, the criterion be-

ing failure at 1760 volts ms. Individual laminations were carried from position to position by vacuum fingers mounted on a turret. Again locking relays were used, in this case to operate a solenoid controlled valve in the vacuum line at the right time in the turret indexing cycle to sort the laminations as class *A* or *B* mica.

Experience with these machines and with others that followed brought into being a more or less orderly body of knowledge as to what features are desirable and what constitutes good design in an automatic test machine.

Test for the Tester

If a testing machine is to have speed, reliability and long life, attention should be paid to the following matters:

Reduction of the test process time to as low a figure as the capabilities and use of the product will permit. Thus, if one of the requirements of a capacitor is a maximum limit on its leakage current measured after a charge time of 60 seconds, and if the materials and manufacturing process are such that a unit is surely good or bad after a 25-second charge, then the machine may be designed to charge for, say, 30 seconds. Frequently the only limitation is the speed of the machine itself. When this is true, it must be worked out so as to satisfy the needed production rate. Obviously the machine should satisfy the rate of the line it serves, or more than one machine should be provided.

Rationalization of the number of test positions in the machine with the production rate and the total test process time. This requires breaking the test time into bits equal to the desired output cycle. In the previous example, if the output needed is a capacitor every 5 seconds then the 30-second charge will have to extend over 6 positions.

Ruggedness. This must be stressed, even at the expense of space, power consumption, and dollars of first cost. If a project is large enough to justify automatic test facilities, then any down time associated with it will be expensive. Good mechanical design is essential.

Provision of self-stopping and alarm features to serve in the event of certain types of failure. A limited torque clutch in the main drive will prevent jamming and damage caused by parts getting into the wrong places, or in certain applications, overload cutouts will suffice. Gong and lamp alarms are desirable to attract attention. The point is that allowance must be made for mishaps which, without precautions, could result in prolonged shutdowns of the equipment.

Provisions for adequate checking for accuracy. Accessible check points and suitable easy-to-use standards are essential. Checking intervals are de-

TABLE I

Function	Example
1. Sorting. a. sorting good from bad. b. sorting into cells for selective assembly.	Network testing machine at Indianapolis. Relay coil test set at Kearny. Capacitor test machine at Hawthorne.
2. Adjusting.	Adjusting machine for flat type resistors at Haverhill.
3. Calibrating.	Calibrating machine for oscillator film scales at Kearny.
4. Plotting data.	Continuous thickness test systems for alpeth and stalpeth cable sheath at Hawthorne and Kearny.
5. Operation of wired equipment. a. to verify accuracy of wiring or fulfillment of purpose. b. to enable prompt location and correction of faults.	Cardomatic and tape-o-matic test sets for key telephone equipment and wired relay units at Hawthorne and Kearny.

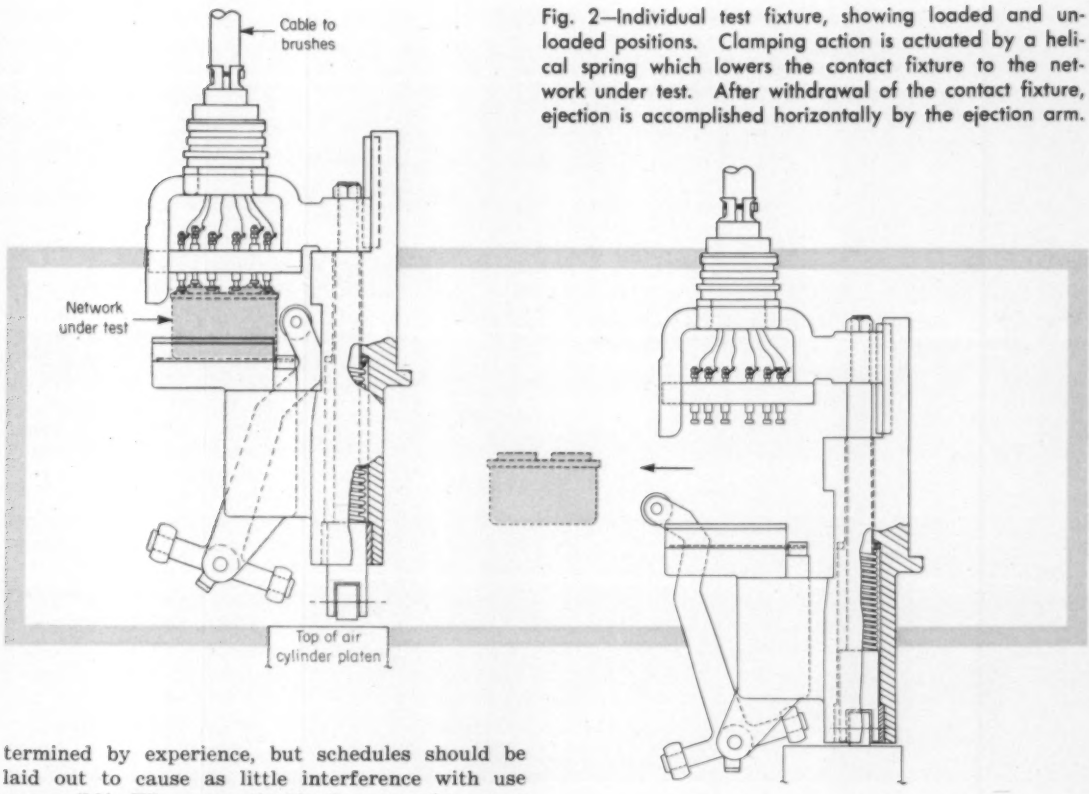


Fig. 2—Individual test fixture, showing loaded and unloaded positions. Clamping action is actuated by a helical spring which lowers the contact fixture to the network under test. After withdrawal of the contact fixture, ejection is accomplished horizontally by the ejection arm.

termined by experience, but schedules should be laid out to cause as little interference with use as possible. Where practicable there may be means for self-checking in the regular operation of the machine. In this case, periodic checking of the checking devices themselves is necessary.

Incorporation of features in the product and in the handling methods that will facilitate automatic handling. This requires the co-operation of the product design and product manufacturing interests. It is axiomatic that automation in manufacture requires special consideration in product design. Automatic testing imposes the same requirement. A notch or a lug may be needed for proper use of automatic feed devices, or terminals may have to be properly chosen. Again, the method of transport from the previous operation needs to be studied, rationalized, and fully agreed upon. If continuous conveyor transportation can be justified, so much the better. In consideration of conveyor feed, the need for time flexibility must not be overlooked. It is important that provision be made for easy storage of product whenever the test machine is inoperative, should a breakdown of this machine shut down the entire line.

Arrangement of the events in the operating cycle in such a way that their sequence is reliably self-determined. This is comparatively straightforward when the programing is done by gear driven cams or other mechanical means; it requires care when switching logic is used. Switching engineers are familiar with the phenomena known as "relay races" and "sneak circuits." These have psychophysical analogies wherever humans and machines work together. Prevention of both the switching errors and their analogs is essential in automatic test set design. Interlocks must be provided against any conceivable mishap.

Enough margin and design flexibility in electrical and mechanical parameters to cope with reasonable variations in product design. Improvements are constantly being made in telephone apparatus and equipment, and these occasionally result in major redesigns or in entirely new systems. Also the need for adding new features to a growing complex of existing telephone plants causes the generation of an endless variety of special equipment. The product designer needs as much freedom as can be afforded. There must be enough flexibility in the costly automatic test sets to permit adaptation as new product designs come along.

These considerations are in addition to the fundamental matters of personnel safety and comfort, motion economy, quietness and appearance.

While dealing with general considerations we must recognize one important difference between the product design and the facilities design problems. In product design there is a premium on optimization of parameters, or striving toward perfection. There is generally opportunity for winning this premium on later tries even though the rush for first production may have denied it to us in the original design. In facilities design there is no such long-term premium and frequently no such opportunity. While careful design is very important, the real premium here is on a device that will do the required job and that can be put

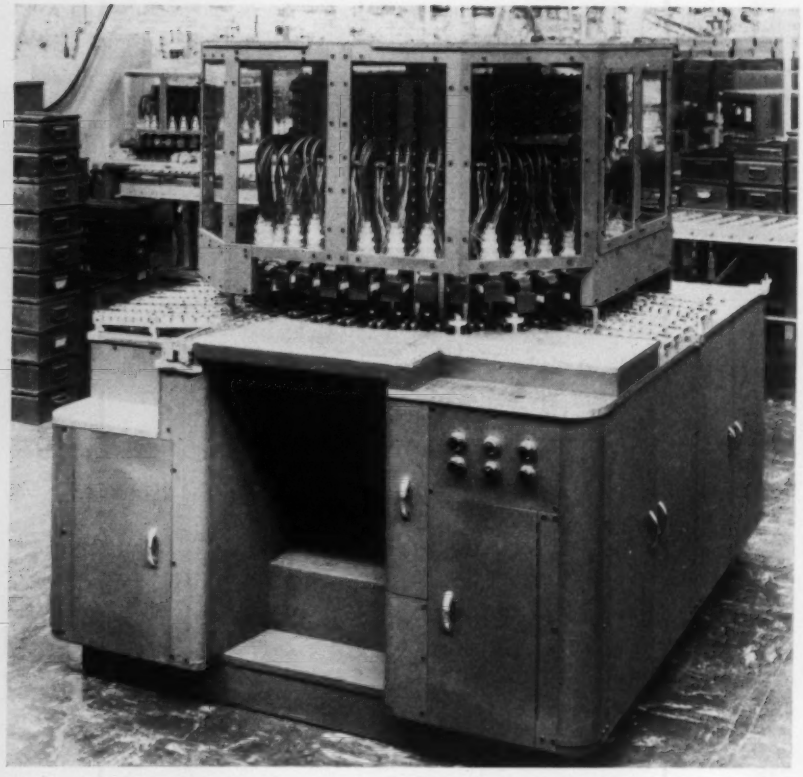


Fig. 3—Network testing machine stripped of its production line accessories. Individual fixtures on the turret are visible. Notice the 8 raised contact fixtures of the loading positions.

in use in time for early production. Once the facility is in use it may be starting on a productive life that will run thirty years or longer. The designer may think of countless ways to improve it or to redesign it completely. If his improvements or redesign can be proved on a business basis, they may be undertaken. The evolution that has taken place in test set designs has been possible mainly because the customers have wanted newer products, or products delivered at a greater rate. Advancement has been attained under a compulsion to take each step quickly and surely. This has represented a real and continuing challenge to the test engineering force.

▶ Principles Put to Work

With these general considerations in mind, it is of value to examine in some detail a modern testing device. The network testing machine in use in Indianapolis is part of the manufacturing facilities for the 425B network used in the 500 series telephone sets to furnish the transmission link between the handset and the line. Network shop testing requires three tests for transmission, three for capacitance tolerance, three for leakage current, two for ac dielectric strength, one for dc dielectric strength and four for continuity. The rotating turret type test machine, *Fig.* 1, performs all these tests, applies a conditioning "burnout" voltage and counts and date-stamps the good networks. Rejects from each test position are segregated on roller conveyors.

The turret contains forty test fixtures, *Fig.* 2, and the machine has forty positions, *Fig.* 3. The turret rotates continuously, causing eleven contact brushes associated with each fixture to pass against fixed commutator segments and a ground ring associated with the test positions. As each fixture advances past one test position a gear-connected camshaft rotates through a complete cycle. Seventeen switches are operated by the cams to assure the proper sequence and timing of the conditioning and testing events occurring at the various positions. TABLE 2 shows the order of the positions and the approximate timing, with respect to cam rotation. The result of the test at each test position is remembered by a self-locking relay until the fixture comes just opposite the entrance to the corresponding rejection chute. At that instant a cam switch closes and causes rejection if the test result indicated a failure. Unloading into the rejection chutes is effected by compressed air operated cylinders.

The clamping movement of each fixture as it leaves the loading area (entering Position 7) is driven by a helical spring which lowers the contact fixture over the terminals of the network, bringing spring loaded plungers into contact with the terminals. At a rejection location a plunger rises, driven by an air cylinder under the control of a solenoid operated valve. The rising of the plunger first forces the fixture to unclamp against

the compression of the helical spring, and then operates an ejection arm which drives the network horizontally out of the fixture. The top rollers of several of these ejection arms can be seen in the fixtures at the front of the machine in *Fig.* 3.

Measuring circuits associated with the various test positions are straightforward. If there is a dielectric failure in one of the breakdown tests at Position 8 or 9, the current through a relay coil in series with the test exceeds a predetermined value. This causes another relay to lock and remember the failure until the network reaches the reject location.

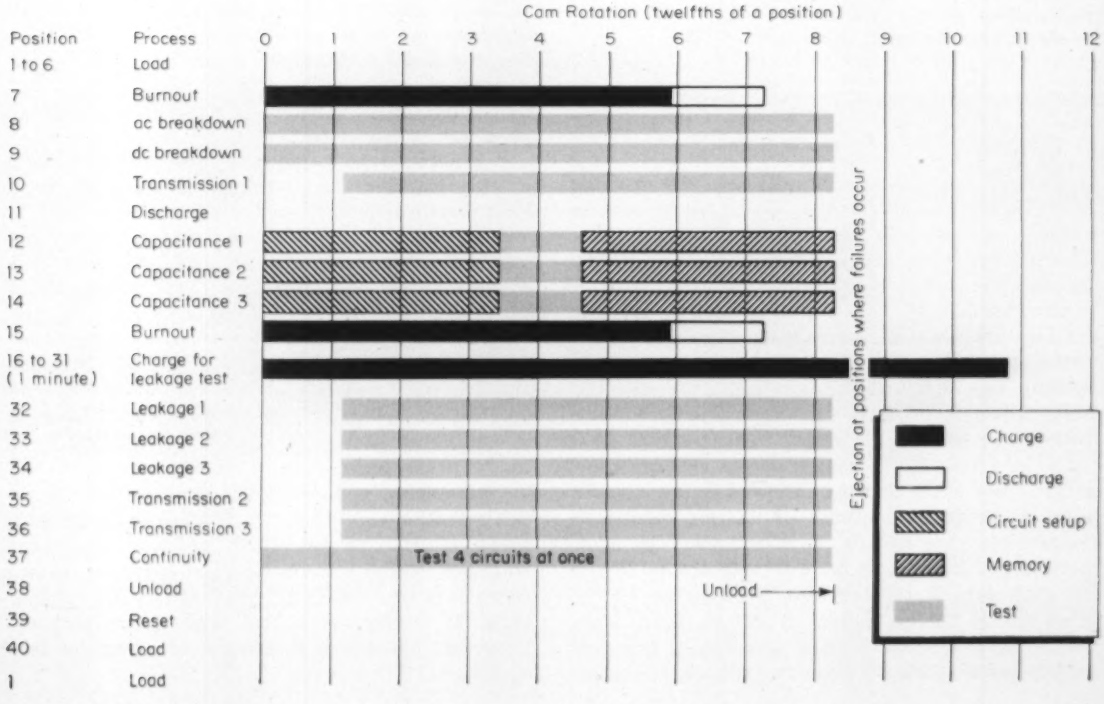
In a typical transmission test position (Position 10, 35 or 36) fixed-voltage, swept-frequency signal, 300 to 3500 cps, is impressed across two terminals of the network. The three tests are for transmission and short and long line sidetone with suitable terminations connected as in actual use. In each case the signal from two output terminals should be less than or greater than a specified value. This signal is amplified and fed to a sensitrol relay, which is mechanically biased in amount and sense to correspond to the limit. If the sensitrol operates it prevents rejection.

In the three capacitance test positions (12, 13, and 14) capacitors in the network are connected into a 60 cps comparison bridge. The output signal from the bridge is amplified and rectified, and impressed on a balanced dc amplifier which drives a sensitrol relay. If the bridge is out of balance—that is if the capacitance is greater or less than nominal—current flows in the relay, but always in the same sense. If the current in the relay exceeds an amount corresponding to either capacitance limit, rejection occurs. Determination of which capacitance limit was violated is done manually in a separate analysis of defects. It may be observed also that any rejection at the capacitance positions could have been caused by a loss unbalance of the bridge. If the conductance of the test capacitor were such as to cause this, it would so appear in the separate analysis. The effect of any ordinary conductance deviation at 60 cps is negligible. Quality is protected by the fact that a conductance deviation could not cause an out-of-limit capacitor to be accepted.

Considerable pains are taken at each capacitance test position to prevent damage to the equipment from various kinds of mishaps. The sensitive winding of the sensitrol is short circuited at all times except for about 0.2-second when the actual test is performed. This prevents damage and erroneous rejections that would otherwise be caused by switching transients from this and other circuits. During the short interval of actual test no other switching takes place in the machine.

A fixture that contains no network because of rejection at an earlier test position or because an operator failed to load it, would cause open circuit in one bridge arm on capacitance test. Without intervention this would cause a violent unbalancing of the bridge, overloading of the detector system and possible damage to the sensitrol.

TABLE II - SEQUENCE OF EVENTS IN NETWORK TEST MACHINE



Ordinary methods of limiting the overload signal would be only partially effective and would detract from the sensitivity. To forestall this trouble from empty fixtures, each capacitance test position is equipped with a limit switch which is operated by a dog at the bottom end of the ejection arm of any empty fixture. When the limit switch operates, it causes the bridge to be disconnected from the test leads and connected to a capacitor that is just out of limits, several tenths of a second before the removal of the short circuit from the sensitrol. Then when the test is made it results in a rejection.

THE AUTHOR

D. T. ROBB has worked on measurement and testing problems with the Western Electric Co. since his graduation from the University of Chicago in 1927. In the electrical laboratory at Hawthorne Works, Chicago, he specialized in ac standardization. Later he worked on the development of shop test methods and test sets. In 1944 he transferred to a WE plant in New York to take charge of radar test engineering. In 1946 he supervised the engineering of the standards laboratory in Winston-Salem, N. C. Currently he has charge of transmission test set development and test set design at the Kearny Works, N. J.

Also, an interlock circuit will stop the machine if a failure of the bridge and detector system causes an empty fixture not to show rejection. This serves as a random occasional check on the functioning of the circuit.

Conditioning of the three capacitors for the leakage current tests begins at Position 16. Because of charging and absorption currents obscuring the effect of pure leakage, the test for leakage is made to an arbitrary current limit specified at one minute of charge. To insure that good units pass the test, it is desirable to use the whole minute. But if the leakage current reading is taken after more than a minute of charge, quality is jeopardized. Accordingly, it is necessary to make sure that the charge is for a minute and no longer on each capacitor. Therefore, at Position 16 the first unit is put on charge, at 17 the second unit, and at 18 the third. Then at Position 32 the first unit is tested while the other two remain on charge. At 33 the first unit is discharged, the second tested, and so on.

The leakage test itself is made by measuring the voltage across a large resistor in series with the test capacitor and a dc voltage source. The energy in this signal is small and must be amplified before there is enough to operate a sensitrol. A dc amplifier with high input impedance is used for this purpose. In addition, the mechanical bias of the sensitrol is kept small to increase sensitivity, and a carefully controlled dc biasing source is used to insure accuracy and stability.

At Position 37 three capacitors and a coil winding are given a final check for continuity. The test of the winding is made by connecting it in series with a relay coil (say No. 1) and battery. If current passes, Relay 1 operates. The three capacitors are tested simultaneously by connecting each of them in series with an 8000 cps source and detectors which consist of bridge type rectifiers and relays. If all of these three relays operate, a series connection through their closed contacts causes another relay to operate and lock. Finally this relay when operated has open contacts in parallel with open contacts on relay No. 1, so that when the reject cam closes it finds an open circuit and rejection does not occur.

The reader may question the necessity for continuity tests on capacitors that have already been tested for capacitance. Perhaps the most convincing answer is that there is an occasional failure on the continuity test. Telephone apparatus is always exposed to more severe conditions in test than it will encounter in ordinary use. The leakage resistance charge and test operations and the transmission tests can on rare occasions cause the metallized connections at the ends of the capacitors to open. As the cost of making the final continuity test is vanishingly small, the additional insurance is economical.

It is interesting to note the labor saving virtues of this machine. The operator in one eight-hour shift handles over five tons of networks—easily and without fatigue. Testing would not be attempted on a manual basis, because over and above multiple handlings, the added human effort of closing fixtures, operating switches and the like could not be tolerated.

Several new machines are under development, and modifications are in progress extending the application of some present machines. There is a continuing search for new fields in which to apply these techniques. A staff portion of the manufacturing engineering force now devotes its full attention to automation techniques in general, keeps abreast of the field, catalogs important additions to the literature, lends assistance in the solution of problems, and develops specific applications. It is likely that the near future will see important extensions in the use of automatic test equipment.

ASSEMBLING HOUSINGS IN AUTOMATIC WELDER

FEEDING and welding components on refrigerator compressor housings in a single automated machine illustrates one of the present popular trends in manufacturing. More and more companies are finding it practical to combine and integrate assembly operations in machines which perform as many operations automatically as the economics of the situation allow.

Use of refrigerator compressor assemblies is large enough that it led to the building of the machine unit shown in *Fig.* 1 by National Electric Welding Machines Co. This 12-station dial indexing machine welds ten separate parts to shells which then are used as the upper halves of refrigerator compressor housings. Welding times are automatically timed and all machine functions interlocked by means of limit switches and relays, *Fig.* 2. Identified in *Fig.* 3 are the shell, short charge fitting, long charge fitting, motor-protector retainer, terminal cover post, three terminal bushings, shaft retainer, connector bracket, and suction screen filter which are assembled to form the welded unit shown. Design of the machine and tooling is such that components can be welded to shells of three different sizes.

Positioning and welding of these parts, before development of the 12-station machine, was performed in single station machines with stockpiling

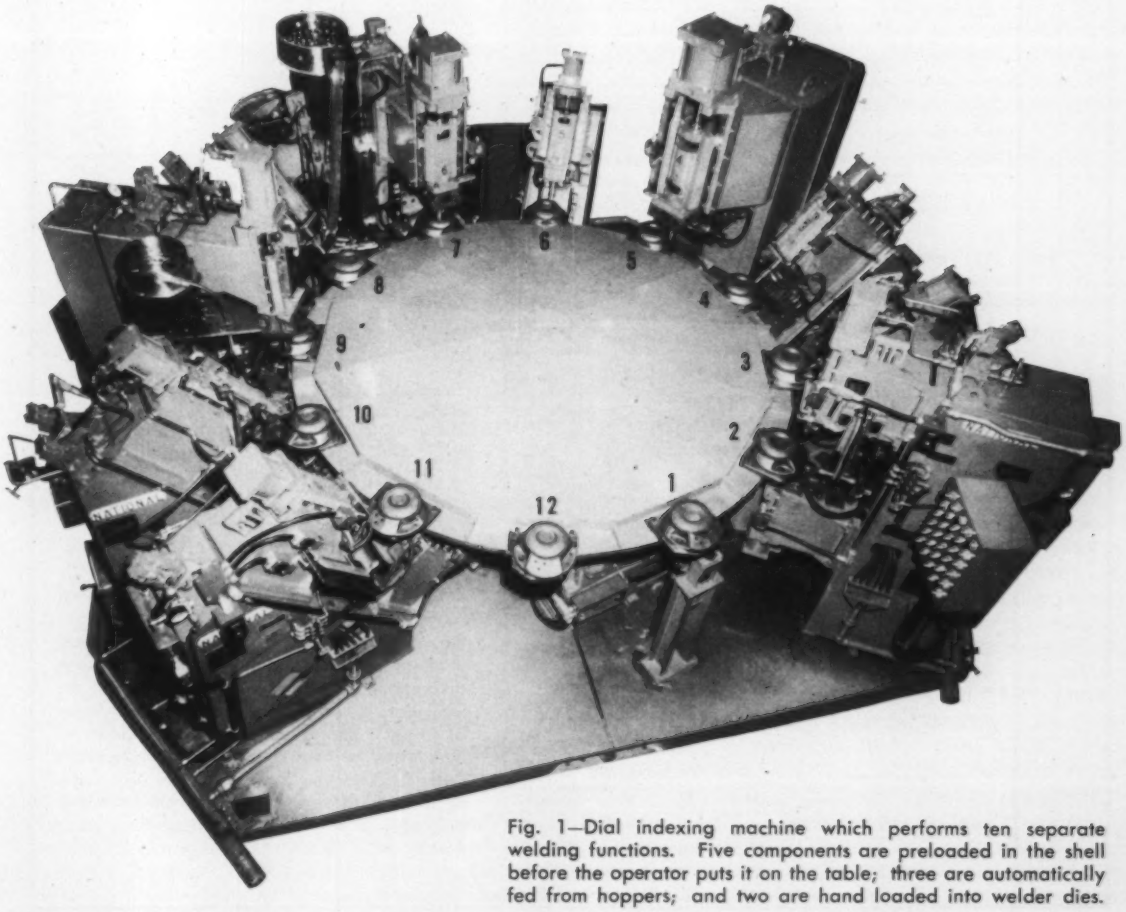


Fig. 1—Dial indexing machine which performs ten separate welding functions. Five components are preloaded in the shell before the operator puts it on the table; three are automatically fed from hoppers; and two are hand loaded into welder dies.

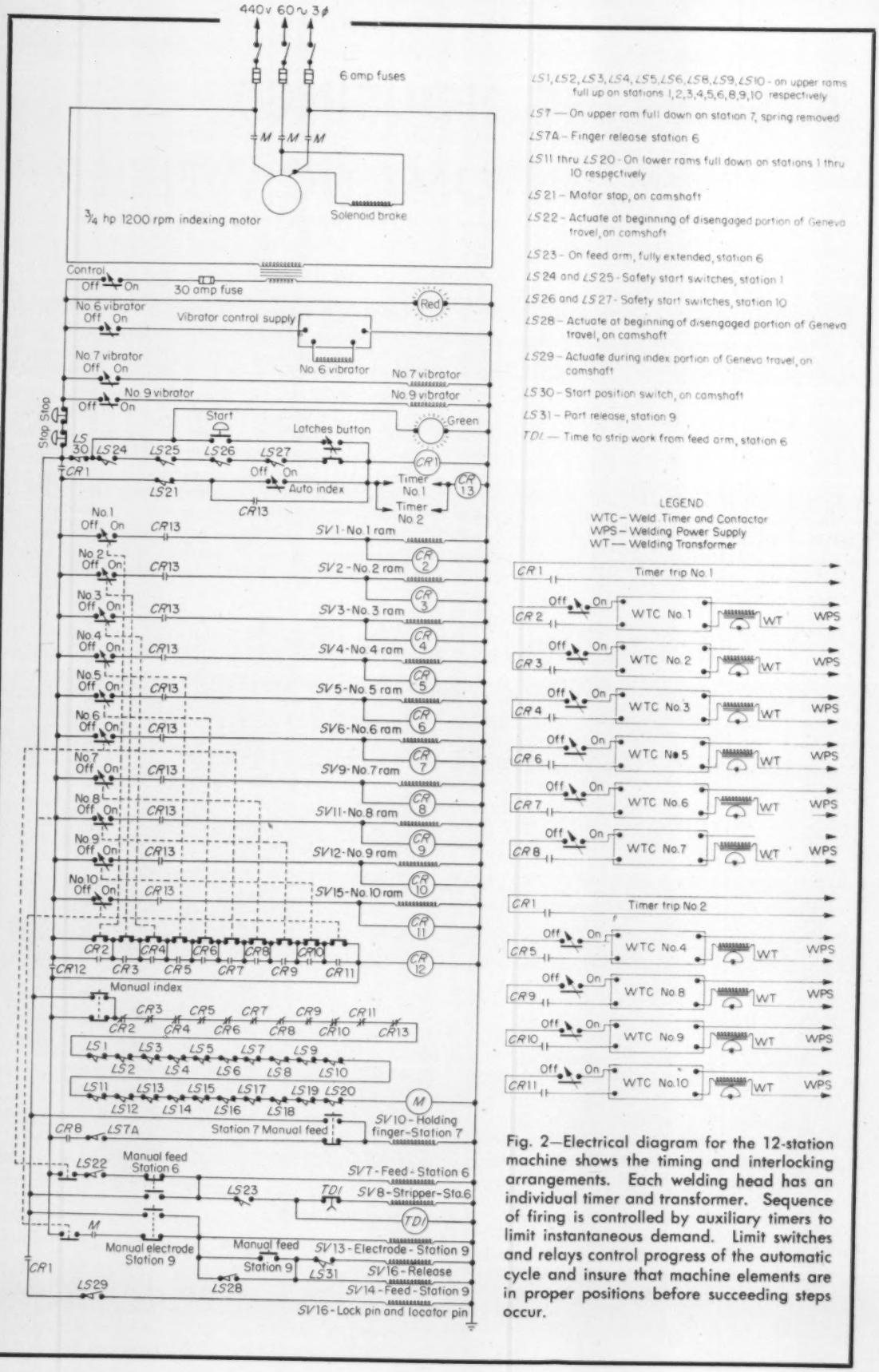

440v 60~ 3ϕ
6 amp fuses
M M M
3/4 hp 1200 rpm indexing motor
Solenoid brake
Control
Off On
30 amp fuse
Red
No. 6 vibrator
Off On
Vibrator control supply
No. 6 vibrator
No. 7 vibrator
Off On
No. 9 vibrator
Off On
Stop Stop
Start
Latches button
Green
LS 30
LS24 LS25 LS26 LS27
CR1
Off On
Auto index
LS21
CR13
Timer No. 1
Timer No. 2
CR 13
No. 1 Off On CR13 SV1-No. 1 ram
No. 2 Off On CR13 SV2-No. 2 ram
No. 3 Off On CR13 SV3-No. 3 ram
No. 4 Off On CR13 SV4-No. 4 ram
No. 5 Off On CR13 SV5-No. 5 ram
No. 6 Off On CR13 SV6-No. 6 ram
No. 7 Off On CR13 SV9-No. 7 ram
No. 8 Off On CR13 SV11-No. 8 ram
No. 9 Off On CR13 SV12-No. 9 ram
No. 10 Off On CR13 SV15-No. 10 ram
CR 2 CR 4 CR 6 CR 8 CR 10
CR12 CR 3 CR 5 CR 7 CR 9 CR 11
Manual index
CR 3 CR 5 CR 7 CR 9 CR 11
CR 2 CR 4 CR 6 CR 8 CR 10 CR 13
LS 1 LS 3 LS 5 LS 7 LS 9
LS 2 LS 4 LS 6 LS 8 LS 10
LS11 LS13 LS15 LS17 LS19 LS20
LS12 LS14 LS16 LS18
M
CR8 LS7A
Station 7 Manual feed
SV10-Holding finger-Station 7
LS22
Manual feed Station 6
SV7-Feed-Station 6
LS23
TDI
SV8-Stripper-Sta.6
TDI
M
Manual electrode Station 9
Manual feed Station 9
SV13-Electrode-Station 9
LS31
SV16-Release
CR1
LS29
LS28
SV14-Feed-Station 9
SV16-Lock pin and locator pin
LS1, LS2, LS3, LS4, LS5, LS6, LS8, LS9, LS10 - on upper rams full up on stations 1, 2, 3, 4, 5, 6, 8, 9, 10 respectively
LS7 — On upper ram full down on station 7, spring removed
LS7A – Finger release station 6
LS11 thru LS20 - On lower rams full down on stations 1 thru 10 respectively
LS21 – Motor stop, on camshaft
LS22 – Actuate at beginning of disengaged portion of Geneva travel, on camshaft
LS23 – On feed arm, fully extended, station 6
LS24 and LS25 - Safety start switches, station 1
LS26 and LS27 - Safety start switches, station 10
LS28 – Actuate at beginning of disengaged portion of Geneva travel, on camshaft
LS29 – Actuate during index portion of Geneva travel, on camshaft
LS30 – Start position switch, on camshaft
LS31 – Part release, station 9
TDI — Time to strip work from feed arm, station 6
LEGEND
WTC – Weld Timer and Contactor
WPS – Welding Power Supply
WT — Welding Transformer
CR 1 Timer trip No. 1
CR 2 Off On WTC No. 1 WT WPS
CR 3 Off On WTC No. 2 WT WPS
CR 4 Off On WTC No. 3 WT WPS
CR 6 Off On WTC No. 5 WT WPS
CR 7 Off On WTC No. 6 WT WPS
CR 8 Off On WTC No. 7 WT WPS
CR 1 Timer trip No. 2
CR 5 Off On WTC No. 4 WT WPS
CR 9 Off On WTC No. 8 WT WPS
CR10 Off On WTC No. 9 WT WPS
CR11 Off On WTC No. 10 WT WPS

Fig. 2—Electrical diagram for the 12-station machine shows the timing and interlocking arrangements. Each welding head has an individual timer and transformer. Sequence of firing is controlled by auxiliary timers to limit instantaneous demand. Limit switches and relays control progress of the automatic cycle and insure that machine elements are in proper positions before succeeding steps occur.

and manual transfer from one operation to the next. The multistation unit incorporates the operations into a single handling job, saving time, material and space.

Parts Feeding

The short charge fitting, the suction screen filter and the three terminal bushings are positioned in the shell before it is loaded on the index table by an operator. The shaft retainer, the motor-protector retainer and the terminal cover post are automatically fed from hoppers at the stations where they are welded to the shell. The long charge fitting is manually loaded into the upper die of Station 2 and the connector bracket is similarly loaded into the upper die of Station 11. Two operators place the five parts on the shell, load the shell onto the dial table, load the long charge fitting and the connector bracket into their respective dies and unload the welded assembly. With two operators performing these functions, 180 assemblies

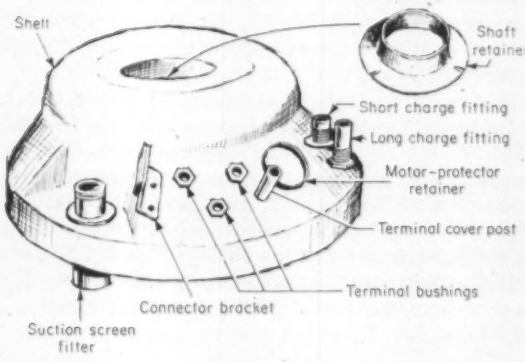


Fig. 3—Illustration of one design for volume production. Components are welded together to form half a refrigerator compressor housing.

are produced per hour. The machine indexing rate can be set up to 360 per hour, but it was found to be more convenient to operate the equipment at a slower rate in order to limit power demands and number of operators.

Welding Operations

Ten welding operations are involved, one for each of the parts assembled to the shell. The welding operations are performed at separate welding stations. Each of the ten welding stations is furnished with an individual press-type welder complete with welding transformer. Every welder incorporates both upper and lower rams, each carrying a die which is connected to the transformer secondary conductors. Weld pressure and weld pressure backup is provided completely for each weld by the welder at that station, so that the indexing table does not carry the welding forces. Rams are air operated and are all operated at one time, remaining under pressure until welds at all ten stations are completed. Time of each weld is controlled individually by means of a timer and ignitron tube electronic contactor for each station. Auxiliary timers control firing sequence to prevent simultaneous demands of power by all welders. Stations 1, 2, 3, 5, 8 and 9 are rated at 75 kva, Station 4 at 250 kva, Station 6 at 100 kva, Station 7 at 30 kva and Station 10 at 50 kva. Ratings are at 50 per cent duty cycle in accordance with standards of the Resistance Welder Manufacturers Association.

Sequence of the operations is as follows:

Station 1—Operator loads shell and preloaded parts onto fixture on index table.

Station 2—Ring projection weld of long charge fitting shoulder to shell, fitting loaded in die by operator.

Stations 3 and 4—Ring projection weld two terminal bushings to shell using flat upper and lower dies.

Station 5—Ring projection weld suction screen filter to shell, using straddling dies.

Station 6—Ring projection weld third terminal bushing to shell.

Station 7—Multiprojection weld shaft retainer to shell, using flat dies, part automatically fed prior to welding.

Station 8—Multiprojection weld motor-protector retainer to shell, part automatically fed prior to welding.

Station 9—Ring projection weld short charge fitting to shell, using straddling dies without clamping features.

Station 10—End projection weld terminal cover post to shell, using a collet-type clamping upper die into which the part is automatically fed.

Station 11—Multiprojection weld connector bracket to shell, using flat dies, bracket loaded in die by operator.

Station 12—Operator unloads assembly from fixture.

Indexing

Work is carried from station to station on a 100-inch diameter table which is indexed by means of a 12-station Geneva index plate and arm. The arm is driven through a Reeves 3:1 Vari-Speed drive, a Foote Bros. gear reduction unit and associated gears by a 1200-rpm ¾-hp motor. Indexing occurs in 150 degrees of arm rotation; the drive motor is stopped by a G.E. solenoid brake after each index motion; and the motor is disengaged until the required dwell time passes. Limit switches actuated by a camshaft driven from the indexing mechanism sequence other functions with table motion. Air cylinder operated locking pins hold the position of the table during dwell. Safety limit switches prevent indexing or other functions from occurring unless all machine elements are in their proper positions. Transfer feeder mechanisms, an electrode feed at Station 10, and a stripper at Station 7 are automatically actuated by means of relays and limit switches.

INTEGRATED SYSTEM SPEEDS

PRODUCTION FINISHING

CO-ORDINATED operation of a multiconveyor system in an integrated production line is a well-proved production technique in the automotive industry. The experience of the industry can be of value to other industries—not necessarily because all companies are faced with problems of equal magnitude but because the automotive systems prove out the technical feasibility of complex solutions to problems of any magnitude.

In paint shop operations, the conveyorized installation at the Chrysler Corp.'s DeSoto body plant illustrates one of the more efficient and flexible finishing systems designed for the automotive industry. The system was designed, built and installed by the R. C. Mahon Co. It includes a main system comprised of two parallel production lines, a two-tone and finish repair system, and a final prime and finish coat repair system after trim, *Fig.* 1. The main system was designed to process 60 automobile bodies per hour. Various co-ordinated conveyors carry automobile bodies through bonderizing, painting, drying, grinding, polishing and upholstering operations until the bodies are lowered into trucks for transportation to final assembly lines. Bodies are mounted on a cradle at the beginning of the overhead conveyor line and are carried through the painting system in the cradle until completely processed.

The conveyor system was furnished by Jervis B. Webb Co. and is composed of 44 power and free conveyors and six floor-type conveyors. The 50 conveyor lines are capable of being controlled from a master control panel and are divided into several independent systems with main conveyors in each system synchronized to start and stop as a unit and to change speeds together. This permits the transfer of carriers between conveyors automatically without jamming.

Production requirements dictated that the conveyor system provide a high degree of flexibility in handling of individual carriers—a requirement for which the power and free form of conveyor is particularly well suited. There was, for instance, the problem of equalizing the movement of carriers through various processing steps subject to varying rates of production. Then, too, there was the problem of repair of the carriers, and the important question as to how to handle work in process during the hours when the line was not being worked.

As can be seen by the diagram, the system provides room for storage of cradle-mounted bodies ahead of the first finishing treatment in order to create a cushion at the beginning of the operation. In the vicinity of the main ovens can be seen the special night storage spaces provided to hold the partially processed bodies which cannot remain in the booths between shift operations, *Fig.* 2. The system also provides that individual carriers can be switched out of the production line for

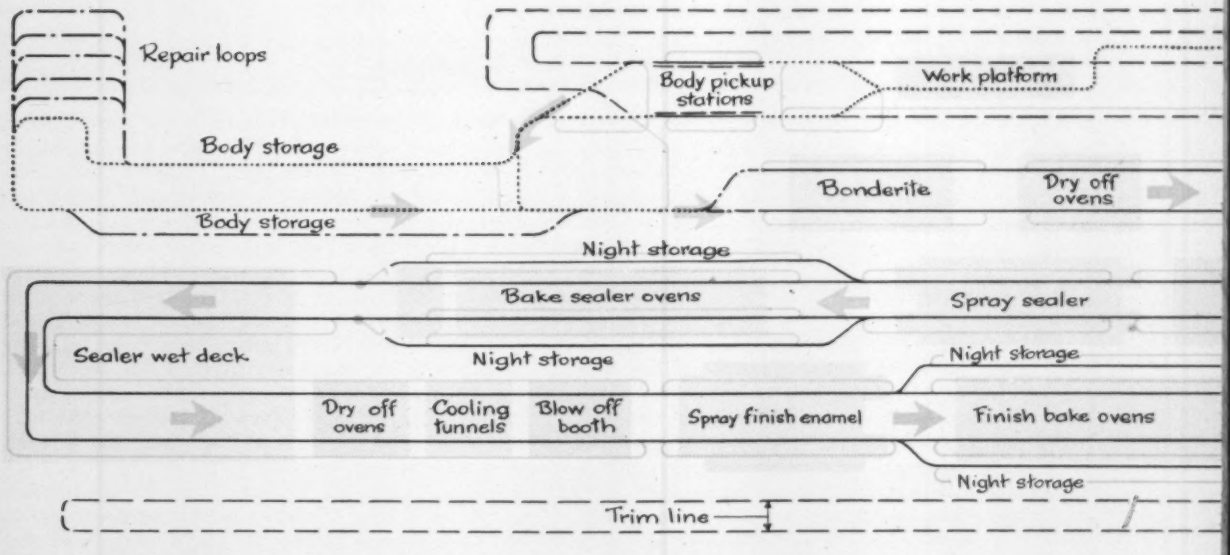


Fig. 1—Diagram of finishing system at DeSoto body plant. The paint system was designed and installed by R. C. Mahon Co.; the conveyors for the integrated system were built by Jervis B. Webb Co.

repairs and excess carriers can be removed or fed into the production line as required. At the end of the main system is located a relatively complex switching setup for power and free conveyors. Bodies at this point might be directed to the body drop section, repair storage, or to the special painting area if special painting is required. At those points where the body is transferred from floor conveyor trucks to the power and free conveyor, or from the power and free back to trucks at the end of the finishing operation, the operator is required only to swing hooks into and out of place. The trucks and carrier are automatically positioned with respect to each other for ease of transfer.

The master control room for the system contains one of the earlier graphic panels applied to a complex system. Light signals on a panel provide the central dispatcher with information as to whether or not synchronization of conveyors can be accomplished and, also the location of trouble if operations are not normal. The dispatcher console contains the controls required to operate the system: Speed indicators, switch position indicators, various switches controlling start-stop, signal and speed changing operations.

The elements of the several finishing systems include cleaning and rust-proofing machines, spray booths, dry-off ovens, finish baking ovens, cooling and other enclosures, and a complete filtered air system. The entire installation was especially tailored to fit an existing building, a requirement which did not necessarily simplify the design problems involved. The area within the existing building devoted to the finishing operation was sealed off with masonry walls, and the enclosure is supplied with clean filtered air. This air, which is in addition to the air supplied to the several spray booths, maintains a slight positive pressure inside the finishing enclosure to prevent entrance of dust through conveyor openings. As an idea of the size of the overall system, the filtered air supply system has a capacity of 1,740,000 cubic feet per minute, and a heating capacity of 202 million Btu per hour.

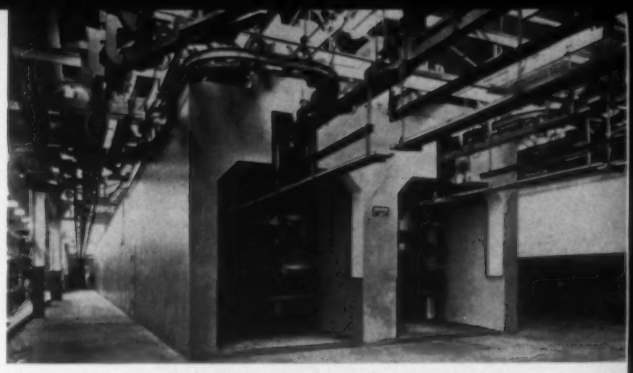
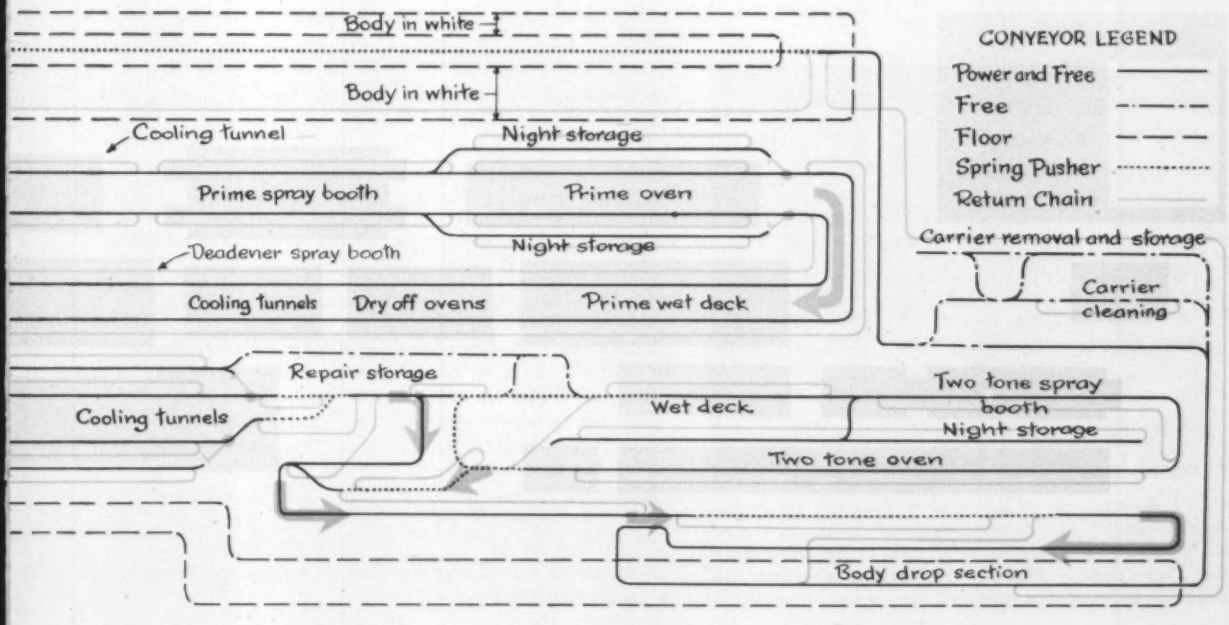


Fig. 2—Typical Mahon finish baking oven installed on the two parallel lines of the main system. The night storage conveyor lines and part of the reversible pivoted transfer units which connect the storage and main conveyor lines are shown on either side of the oven.

The system which has been described is not new, it has been in operation for several years, but it is still one of the top power and free conveyor systems in use today. It illustrates the technique of using conveyors as an integral part of the production line: Bodies are stored, worked on, and completely finished while on the conveyor. The system provides for a central control point where operation and synchronization of various conveyors can be directed. Of equal importance, the system is flexible in operation, containing built-in features which compensate for the hour-to-hour variations in production and provide for efficient finishing of automobile bodies in a variety of colors.



CAM OPERATED HYDRAULIC SYSTEM

MECHANICAL sequencing and timing are used with hydraulically actuated machine elements on a standard No. 2 Cincinnati Centerless Grinder, *Fig.* 1, at Earl A. Thompson Mfg. Co. Operation of the system is based on a camshaft having an individual cam for each of six machine elements which are controlled. Power is transmitted from the camshaft at the proper time and desired rates to each remotely located element through an individual closed hydraulic circuit. Each closed hydraulic circuit not only acts as a power transmission linkage but also converts the throw of the cam into a desired travel of the machine element as determined by the design of the hydraulic circuit. Timed motions can be provided for feeding, chucking, clamping, loading, unloading and similar functions in all types of machines.

In the grinder application mentioned, one face of valve tappets is rough and finish ground to a 3-5 microinch finish at a production rate of 1300 pieces per hour. After parts are oriented and fed to the loader chute, the machine handles each part through its complete cycle and ejects it. The mechanical-hydraulic drive and control unit, called a Hydra-Cam unit, is produced by Earl A. Thompson Mfg. Co. and provides six closed hydraulic circuits which operate and control the following functions: (1) opening and closing of collet, (2) retraction of work spindle and return to work position, (3) part ejection, (4) action of load and unload mechanism, (5) motion of load finger, and (6) feed and rapid return of worktable.

Fig. 1—Photograph of automated grinding setup before equipment was installed to automatically feed and take away valve tappets which are to be ground on their cam faces. Motions of machine elements are sequenced, timed and powered from a single camshaft.

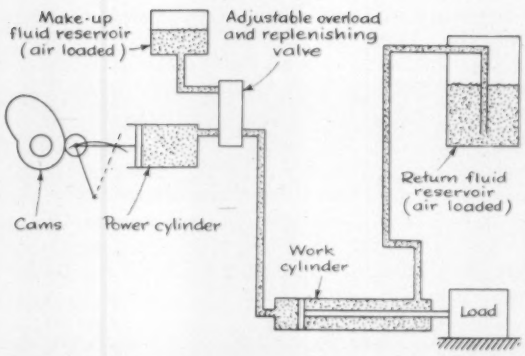


Fig. 2—Individual closed hydraulic circuits, such as outlined in this sketch, are provided for each machine element operated by the mechanical-hydraulic unit. Cams for all circuits are on a common shaft.

In operation of the grinder, the camshaft is driven at one of two speeds made possible by a two-speed transmission. During the grinding part of the cycle, which represents 90 degrees of camshaft rotation, the camshaft is driven at the slower speed of the clutch. For the remaining 270 degrees the rapid clutch is engaged and the camshaft turns at the higher speed. During this part of the cycle the work spindle retracts, the table returns to unload and load position, the collet opens, the ground part is ejected, another part is loaded into the work spindle, the collet closes, the work spindle moves to work position, and the worktable feeds in.

The sketch in *Fig.* 2 illustrates one of the closed hydraulic circuits. The piston in the power cylinder is mechanically advanced by its associated cam on the camshaft. The piston in the work cylinder moves the machine element in response to advance of the power piston. Advance of the work piston causes fluid to be exhausted from the return side to an air loaded reservoir or accumulator. Return strokes of the power and work pistons are powered by flow of fluid from the accumulator. The cam follower on the power piston is thus always in contact with its cam and the hydraulic fluid is always under pressure to exclude air from the power circuit. A pressure sensitive valve and a second air loaded reservoir supply fluid to the system to make up losses and provide an overload relief.

By changing cams, a wide range of characteristics can be obtained. Variations in timing and sequencing or overlapping of motions is obtainable, as well as variations in length of stroke. Types of motions such as constant velocity or harmonic movements can be provided by proper cam design. Also the power cylinders are made with interchangeable bushings so that their displacement can be varied as required for a given installation. A small unit using up to 2 hp has power cylinders with displacements up to 5.7 cu in. per circuit. Cycles can be as fast as one per second, and as many as 11 closed circuits can be controlled from a single camshaft.

HOW PROPORTIONAL PLUS INTEGRAL CONTROL STABILIZES

The engineering mind is always heartened by a theory-to-hardware discussion. Here the author describes various elementary controllers and a more satisfactory, complex mode of control, then proceeds to analyze equipment designed to perform in this mode. Omitted is mention of the labor and skill necessary to leap from theory to practice.

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APPLICATION of a controller to a plant requires an investigation into the stability of the system being created. Such stability consideration is actually a study of the system dynamics which, in turn, is the product of the dynamics of both the controller and the plant.

Certainly, if there were no points within the plant at which energy were stored, the problem would be elementary. The item of interest, the controlled variable, would instantaneously follow the dictates of the controller acting through the manipulated variable, *Fig.* 1. But any physically realizable plant will have energy stored within it in rotating members, in inductances, in thermal capacities, etc. The controlled variable will not instantaneously follow the output of the controller, but rather will lag due to the time needed for necessary energy-level changes at various points. The action in a conventional plant can be seen to go through a series of stages. The dynamic response of such a plant will usually be a series of time lags.

Plant Dynamics

It is most convenient to describe plant dynamics and those of the controller and other system elements in terms of sinusoidal analysis, generally called frequency response analysis. The methods of frequency response have been well explained in other literature (see AUTOMATION, Apr.-Oct. 1955, *Basic Process Control*, Worley) and will not be discussed here. Let it suffice to say that an element will be described by its steady-state response to a constant amplitude sine wave of a particular frequency.

Two curves may be plotted from response information, *Fig.* 2. The first illustrates the amplitude response of the element—the ratio of output amplitude to input amplitude at each frequency, plotted against frequency. This amplitude response is termed *gain*, and this curve will be called the gain response. The second curve plots the phase angle between the input and output in degrees of a sine wave, versus frequency. This curve will be

called the phase response. Both curves are important in determining the stability of a system.

As shown in *Fig.* 1, the system formed by the controller and plant is a closed loop in which the input to the controller is an error between the desired value and a signal representing the controlled variable. The stability of the system is the stability of this loop.

Instability means that the controlled variable will not eventually level off at or near the desired value, but instead, the system will oscillate. In theory, for linear systems, the magnitude of the controlled variable will continue to describe ever increasing amplitude oscillations. In reality, some stop or limit will eventually be reached and the controlled variable may oscillate back and forth between two limit values.

Instability Criterion

At what point does a stable system become an unstable one? The simplest manner to describe a critical value at which instability starts is to examine the feedback signal. Assume that it reaches the summarizer with a phase shift of 180 degrees with respect to the input. Because of the connection of the summarizer, the feedback signal will add to the desired value to form the controller input rather than subtract. If the magnitude of the feedback signal determined by the elements of the loop (as is the phase shift) is at least equal to the magnitude of the desired value, the system is unstable. Put another way, generally the feedback will lag behind the desired value and the amount of lag expressed as phase shift will increase with frequency. For any practical system there will always be a frequency at which the phase shifts in the loop add up to 180 degrees. If the product of all the cascaded gains in the loop is 1.0 or larger at that frequency, the system is unstable and will oscillate at that frequency. From energy considerations, the system will oscillate at the lowest frequency at which the phase shift is 180 degrees and the loop gain is 1.0 or greater.

The only adjustable gain in the loop is usually that of the controller. High gain means a faster acting system and lower steady-state errors, and is thus quite desirable. But these requirements are somewhat at cross purposes with stability considerations which would have low gain. The solution lies in the design of the controller. If the controller could be made to compensate somewhat for the detrimental time lags of the system, then the loop phase shift for a given frequency would be less. The frequency at which 180 degree phase shift occurs would be higher and could perhaps be increased enough such that the gain at that frequency would be below 1.0. In general, plant characteristics are such that gain ultimately decreases with frequency and phase shift increases with frequency.

A device in the controller which could reduce phase shift (at least over a significant band of frequencies) could stabilize an otherwise unstable system. The device which Askania has developed and successfully used for this purpose is functionally named "The Askania Hydraulic Stabilizer".

Overall Frequency Response

For convenience in combining the frequency responses of the controller and the plant to which it is applied, gain and phase responses are often plotted on semilog paper as shown in *Fig.* 2. Gain has been defined in terms of the amplitude response of the element at a particular frequency. Gain in decibels (*db*), a convenient notation, is 20 $\log_{10}$ of the amplitude ratio. The value of this form is evident when the overall gain and phase response of a system comprising a number of cascaded elements is required. First, the individual gain and phase response of each element is plotted. These are often known, and for simple elements there are standard shapes.

Then the responses are combined. The overall gain is the product of all the individual gains.

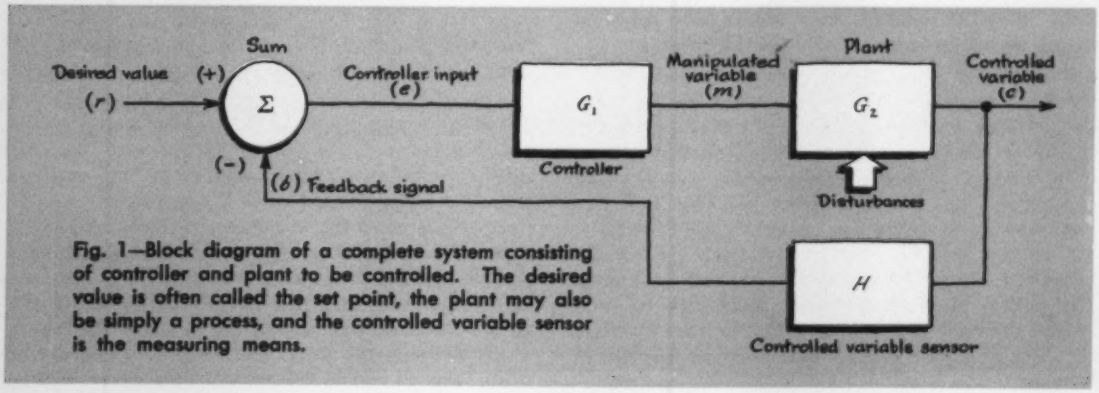

Fig. 1—Block diagram of a complete system consisting of controller and plant to be controlled. The desired value is often called the set point, the plant may also be simply a process, and the controlled variable sensor is the measuring means.

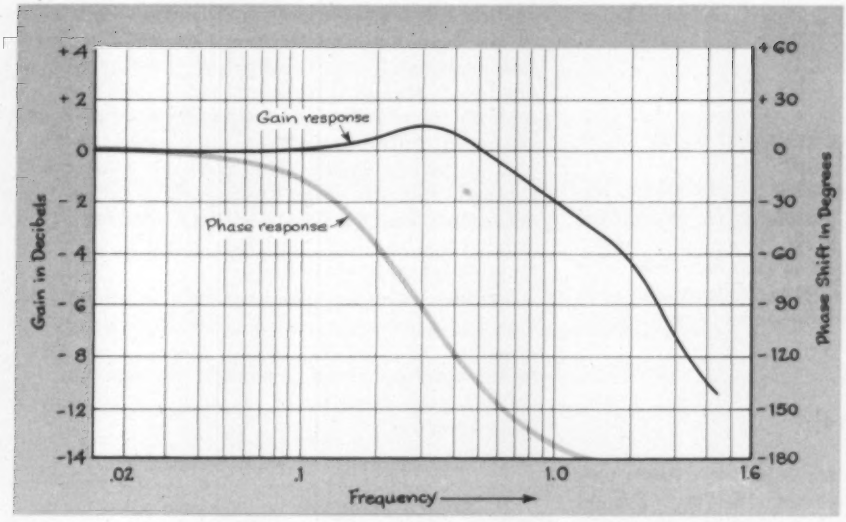

Fig. 2 — Bode diagram showing frequency response of a typical plant. The gain response indicates the ratio of output to input amplitude, and the phase response shows the phase angle between input and output sine waves.

Thus, the sum of the db values of the curves can be added algebraically at each frequency. The curve drawn through the points representing the sums is the required gain response. Similarly, the overall phase shift is the sum of all the phase shifts and these curves can be algebraically added, giving the overall phase response.

Overall gain and phase response obtained can then be studied in terms of the stability criterion previously discussed—the amount of gain at a frequency where the total phase shift is 180 degrees. Note that this criterion was intuitively arrived at by means of consideration of the feedback signal, *Fig.* 1. Therefore, the elements which must be considered in cascade to find overall dynamic response, and thus determine stability are G_1, G_2 and H. To determine stability of the system being created, consideration is given to the cascaded effects of not only the elements in the forward path but those also in the feedback path. Overall gain and phase response of these elements acting on the input, r, produce not the output of the closed-loop, c, but the feedback signal, b.

This gain and phase response, useful for determining the stability of the system, and evaluated by examining the individual frequency responses of the elements in the system, is called the open-loop frequency response. In summary, the open-loop response relates b to r. The closed-loop response would relate c to r. It is by examination of the open-loop response in the light of the stability criterion that the stability of the closed-loop system is determined.

The plant being controlled is an element in the closed-loop. Obviously plants will vary in their frequency responses just as they do in their physical appearances. For simplicity, discussion will be limited to plants being operated in their linear range. That is, given an input of some amplitude x producing an output y, if x were to be increased by some percentage, y would also be increased (in steady state after transients have subsided)

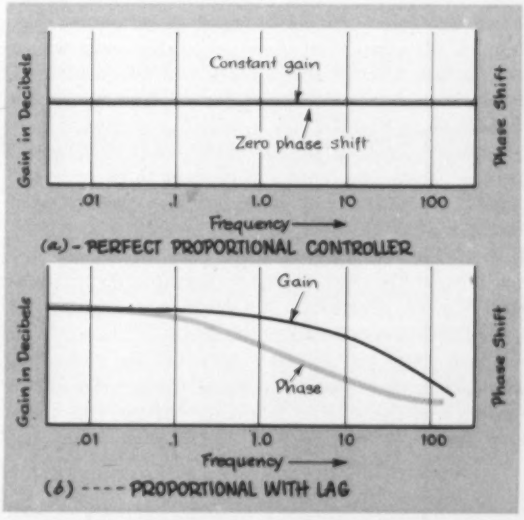

Fig. 3—Frequency response of proportional controller showing a plot of a theoretical compared to an actual controller. The actual proportional controller includes a positioning servomechanism.

by the same percentage.

Most plants have the same general characteristics, so that the frequency response of a typical plant may be shown as in *Fig.* 2. The ratio between plant output and input amplitudes will have a constant value for low frequencies—in this case shown as a gain of 1, that is zero db. As frequency is increased the gain may increase slightly with a maximum value at some resonant frequency. As frequency is increased still further, the gain will decrease. For very high frequency the gain will be very small (large negative db) which means that if plant input is oscillated very rapidly the output will hardly move at all. Furthermore, at low frequencies the plant output will follow its input closely, but as frequency is increased, the time lags of the plant will cause output to lag

input more and more, as evidenced by the ever-increasing negative phase shift.

With the frequency response of the plant, G_2, known, and that of the feedback, H, established by physical considerations (H is usually a sensor for determining the position of the controlled variable and possibly a transducer to produce b in desired form), it remains to examine the controller, G_1.

Proportional Control

The most basic controller is a proportional one. Its output, the manipulated variable (m in *Fig.* 1) is made some multiple of (proportional to) the controller input, e. The proportionality factor relating controller output to input is, of course, the gain of the controller. As defined, the gain would be constant for all frequencies and the controller would have zero phase shift for all frequencies, as illustrated in *Fig.* 3*a*.

A more typical proportional controller would have a positioning servomechanism to provide the "beef" necessary for changing the manipulated variable (for example, for positioning a butterfly valve). This servomechanism can follow well at low frequencies, but begins to lag at high frequencies. *Fig.* 3*b* illustrates the frequency response of a practical proportional controller.

These gain and phase curves of the controller would then be added to those of the plant and the feedback element. The resulting curves, the open-loop frequency response of the system, would be available for analysis. Primarily the total gain of the system at the frequency at which 180 degree phase shift occurs would be investigated. As previously stated, this gain must be below 1.0 or zero db for stability. It will be noted that a decrease in controller gain (usually readily adjustable in the equipment) of a given db value would subtract this db value from each point of the entire open-loop gain curve without affecting phase shift. Thus, the controller gain could be adjusted to provide stable operation.

Another effect of open-loop gain in addition to determining stability of the system is to determine speed of response and steady-state (after transients subside) error. As might be expected, increased gain causes faster response and less steady state error.

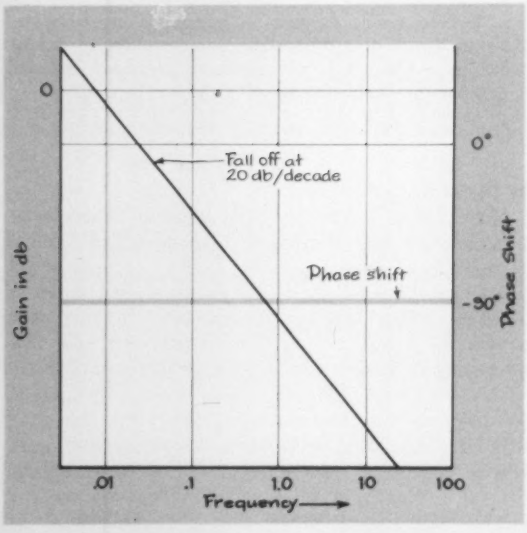

Fig. 4—Frequency response of integral controller. Phase lag is independent of frequency and gain decreases with increasing frequency.

Integral Control

It is most often true that the maximum gain allowable in the system for stable operation does not reduce steady-state error sufficiently. It might be intuitively reasoned that a change from the proportional controller to one with high gain at low frequencies and low gain at high frequencies, where phase shift is in the vicinity of 180 degrees, would establish a system having low steady-state error and stable operation. An integral or floating controller has these characteristics. By nature of the integration, the rate of change of the controller output, m, would be proportional to the controller input, e. If, for the frequency response test the input is $A \sin \omega t$, the output of the controller would be the time integral of this, $(-A/\omega) \cos \omega t$.

Thus, when the frequency response of an integral controller is plotted in the usual manner, the gain is seen to decrease with increased frequency and the phase shift is seen to be constant at -90 degrees. With a decade of frequency being a factor of ten in frequency, the decrease of gain with frequency will be 20 db per decade. *Fig.* 4.

The frequency response of the integral controller can be added to those of the plant and the feedback element, and the open-loop behavior of the system studied. The point at which the gain curve for an integral controller crosses the zero db axis is a function of the constants of the controller, and is usually adjustable. The value of this crossover can be seen to be equivalent to the gain of a proportional controller in that the open-loop gain curve can be raised or lowered a number of db at each point by choice of the crossover point.

It will be further noted that the use of an integral controller has increased the phase shift of the open-loop appreciably. Phase shift of 180 degrees will occur at a lower frequency than it does with the proportional controller. The crossover point of the integral controller must be chosen such that the open-loop gain is less than 1.0 at this frequency. The low frequency open-loop gain will remain quite high and a system has been

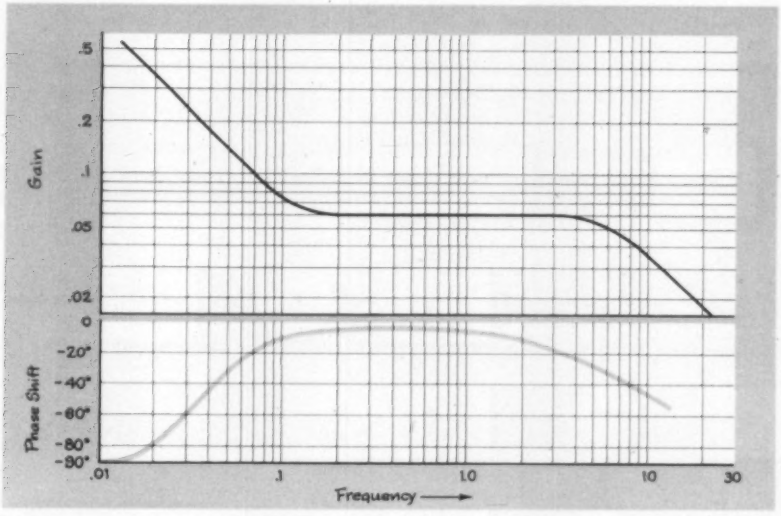

Fig. 5 — Frequency response of a proportional plus integral controller. This controller is similar to an integral at low frequencies, a proportional controller at high.

created which is stable and yet has very low steady-state error. The gain is infinite at zero frequency giving the system low steady-state error.

Because of the large phase shift of the integral controller compared to the proportional one, the system using the integral controller must have less open-loop gain at any given higher frequency. It is the available gain at higher frequencies which determines the speed of response of the system. Thus, the integral controller provides low steady-state error at the expense of sluggish operation when compared to proportional control.

An ideal controller would have the high gain at low frequency of the integral controller. But at higher frequencies, when the plant begins to lag and show appreciable phase shift, the ideal controller would lower its phase shift to the zero degree phase shift of the proportional controller. Thus, more gain could be used at higher frequencies.

▶ Proportional Plus Integral

Such a controller, integral for low frequencies and proportional for high, by compensating somewhat for the illustrated characteristics of the plant being controlled, would provide a system which had low steady state error, fast response and stable operation.

Frequency response of such a proportional plus integral controller is shown in *Fig.* 5. The lag associated with the proportional is evident in the ultimate decrease with increased frequency after the level part of the gain curve. The phase curve starts at −90 degrees, increases to near zero degrees during the proportional region, and ultimately also decreases.

The problem is then one of designing equipment whose frequency response will approximate

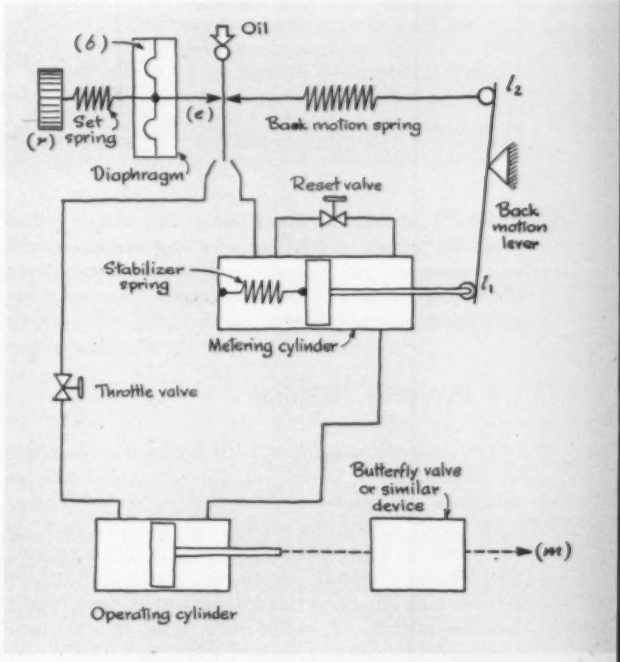

Fig. 6—Schematic diagram of the Askania Jet-Pipe Regulator with Hydraulic Stabilizer. This arrangement will produce frequency response approximating proportional plus integral control shown in *Fig.* 5.

that of proportional plus integral control. It should be noted that a proportional controller followed by an integral controller, for example, will not be satisfactory. The result would be a response resembling that of integral only, with a shift in the crossover point representing the gain of the proportional controller.

An Askania Jet-Pipe Regulator with Hydraulic Stabilizer is a proportional plus integral con-

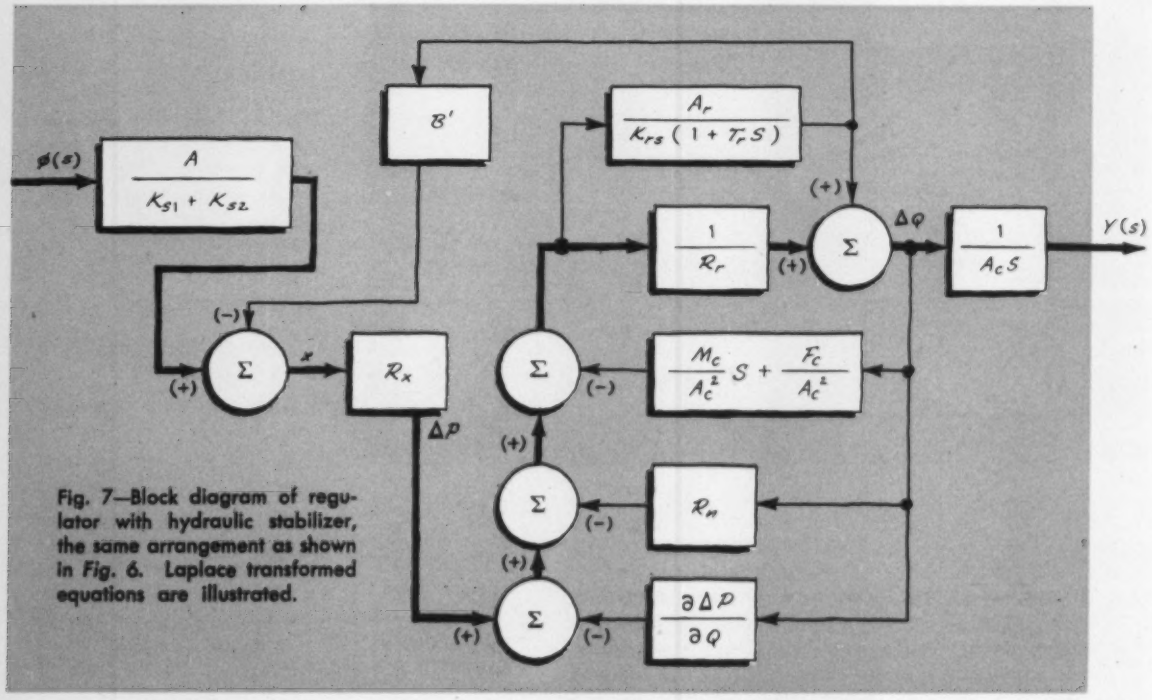

Fig. 7—Block diagram of regulator with hydraulic stabilizer, the same arrangement as shown in *Fig.* 6. Laplace transformed equations are illustrated.

troller. In order to specifically demonstrate this mode of control a schematic of the stabilizer will be presented, the transfer functions derived from the block diagram, and an actual frequency response of the equipment shown.

▶ Hydraulic Stabilizer

The Askania Regulator with Hydraulic Stabilizer is a controller based on the Askania jet-pipe principle. In addition to its controller properties, it contains means for setting the desired value of the variable being controlled, a point for accepting the feedback signal, means for summarizing and establishing an error actuating signal, and finally has an output of sufficiently high, power level to operate directly a valve or similar device.

Schematic of this controller is shown in *Fig.* 6, and has been drawn for the typical case of an input signal consisting of air pressure applied to a diaphragm. Motion of the diaphragm strokes the pivoted jet pipe. As the jet pipe moves through a small angle, a differential pressure is created across two receiving orifices. A stream of hydraulic oil directed by the angle of the jet-pipe will flow in accordance with the differential pressure. The oil ultimately moves a piston in the operating cylinder. It is the position of this piston which is the output of the controller.

Action of the stabilizer occurs through metering of the oil flow. The piston of the metering cylinder (which itself is partially by-passed and is spring loaded) moves an internal feedback lever, which, through a spring, opposes the motion of the jet-pipe. The desired value of the variable is set by compression of a spring bearing against the input side of the diaphragm.

In the standard terms of *Fig.* 1: r is the desired value, set by compression of a spring; b is the feedback signal representing the status of the controlled variable, the pressure against the diaphragm; e is the true controller input, the stroke of the jet-pipe; m is the manipulated variable, the angle or position of the device being operated by the piston of the operating cylinder.

In general, it is of most interest to investigate operation of a system wherein the desired value is held constant and disturbances occur in the plant. Thus, the transfer function of the controller will be developed from the standpoint of constant r and varying b.

The transfer function of a controller illustrates the dynamic relation between magnitude of the input and output of the controller. Therefore some variables must be defined which are the deviations from steady-state value of the various controller variables. Let the variation in r be zero, the variation in b be ϕ, the variation in e be X, and the variation in operating cylinder piston position be Y, during the transient due to the disturbance. Under these conditions $\phi = -X$.

The transfer function will show the dynamic relation between ϕ and Y. It will be written in Laplace notation, that is in terms of the complex variable, s. To develop this transfer function, the differential equations of motion of the various components of the controller have been written.

For these equations, several coefficients must be defined: These are: A_c, area of operating cylin-

der piston; A_r, area of metering cylinder piston; K_{s1}, spring rate of back-motion spring; K_{s2}, spring rate of set spring; K_{rs}, spring rate of stabilizer spring; R_n, (linearized) resistance of oil lines and throttle valve; R_r, (linearized) resistance of reset valve; F_c, viscous damping constant of operating cylinder and piston; F_r, viscous damping constant of metering cylinder and piston; $\partial\Delta P/\partial x$, $\partial\Delta P/\partial Q$, jet pipe characteristics; M_c, effective load inertia (assumed small).

Several of the above coefficients were combined, as follows:

$$R_t = \frac{\partial \Delta P}{\partial Q} + R_n + \frac{F_c}{A_c^2}$$

$$B = \frac{l_2}{l_1}$$

$$B' = B\left[\frac{K_{s1}}{K_{s1} + K_{s2}}\right]$$

$$K_j = \frac{A}{K_{s1} + K_{s2}}$$

$$T_r = \frac{F_r}{K_{rs}}$$

$$R_x = \frac{\partial \Delta P}{\partial x}$$

Differential equations will not be shown here. However, the Laplace transformed equations will be illustrated by a block diagram of the controller showing the dynamic relations, *Fig.* 7. Briefly, the block diagram indicates how the output, $Y(s)$, is related to the input, $\phi(s)$. Because this relationship is a dynamic one, both input and output are shown in their Laplace transformed values. $\phi(s)$ is acted upon by the constants of the diaphragm and springs to produce a stroke. This stroke is summarized with that of the feedback and by jet-pipe action a differential pressure is received.

Differential pressure is reduced by the resultant flow. It is further reduced by line drop. Finally it is reduced by the more complex action of the stabilizer. The corrected differential pressure produces a flow of hydraulic oil. At the end of the block diagram is seen the final relationship: the oil flow is integrated by the operating cylinder to produce the change in output position, $Y(s)$.

Methods of block diagram algebra have been used to convert the block diagram into a single equation relating output to input. Defining $G(s)$ as the transfer function showing this relation, the transfer function of the controller is:

$$G(s) = \frac{Y(s)}{\phi(s)} =$$

$$\left[\frac{R_x K_j}{A_c}\right]\left[\frac{T_r + \frac{A_r^2}{K_{rs}} R_r}{R_r + R_t + \frac{A_r}{K_{rs}} B' R_x R_r}\right]\left[\frac{1}{S\left(T_r + \frac{A_r^2}{K_{rs}} R_r\right)}\right]\left[\frac{1 + \left(T_r + \frac{A_r^2}{K_{rs}} R_r\right) S}{1 + \frac{R_r T_r + R_t T_r + \frac{A_r^2}{K_{rs}} R_r R_t}{R_r + R_t + \frac{A_r}{K_{rs}} B' R_x R_r}}\right]$$

The transfer function can be simplified by defining some new constants. Let

$$K = \frac{R_x K_j}{A_c} \cdot \frac{T_r + \frac{A_r^2}{K_{rs}} R_r}{R_r + R_t + \frac{A_r}{K_{rs}} B' R_x R_r}$$

$$T = T_r + \frac{A_r^2}{K_{rs}} R_r$$

$$T_1 = \frac{R_r T_r + R_t T_r + \frac{A_r^2}{K_{rs}} R_r R_t}{R_r + R_t + \frac{A_r}{K_{rs}} B' R_x R_r}$$

Then:

$$G(s) = K\left(1 + \frac{1}{Ts}\right)\left(\frac{1}{1 + T_1 s}\right)$$

▶ Interpreting the Transfer Function

It has been shown that for typical plant control, a proportional plus integral controller would be desirable. A transfer function for the Askania Jet-Pipe Regulator with Hydraulic Stabilizer, has been developed. This transfer function represents proportional plus integral action.

The transfer function of a proportional-only controller would be $G_p(s) = P$, a constant. The frequency response of this controller is shown in *Fig* 3*a*.

If the controller included a servomechanism to increase the power level, the proportional-only controller would be

$$G_p(s) = P\left(\frac{1}{1 + T_p s}\right)$$

where T_p is the time constant of the servomechanism and P is the gain of the controller at low frequencies (before the effect of the servomechanism becomes apparent). *Fig.* 3*b* illustrates the frequency response of this controller.

The transfer function of an integral-only controller would be:

$$G_i(s) = \frac{I}{s}$$

where I is the gain at a frequency of one radian/second. As with any transfer function, the frequency response of the controller can be obtained by substituting $s = j\omega$ where ω is frequency in radians per second. Gain and phase shift can then be obtained numerically for each frequency.

It can be seen from the above that the cross-

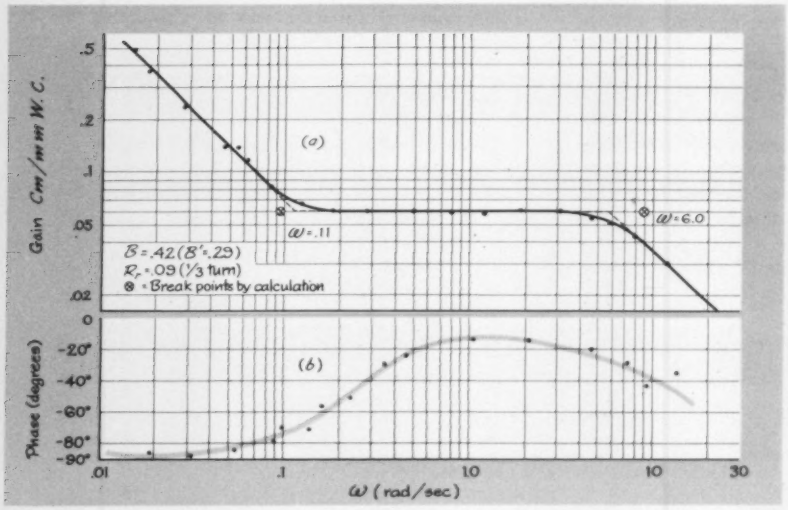

Fig. 8 — Experimentally obtained frequency response of Jet Pipe Regulator with Hydraulic Stabilizer. Note the similarity of results with the plot of *Fig.* 5.

over (Gain = 1.0 = zero db) occurs at $\omega = I$.

If an integral-only controller also has a positioning servomechanism in it, its transfer function would show the time constant of the servomechanism in the following manner:

$$G_i(s) = \frac{I}{s} \cdot \frac{1}{1 + T_p s}$$

The transfer function derived to represent the Askania Jet-Pipe Regulator with Hydraulic Stabilizer was

$$G(s) = K \left(1 + \frac{1}{Ts} \right) \left(\frac{1}{1 + T_1 s} \right)$$

or:

$$G(s) = \left(K + \frac{K}{Ts} \right) \left(\frac{1}{1 + T_1 s} \right)$$

It can be seen from the above that the Askania controller can be thought of as a proportional controller of gain K plus an integral controller of crossover point $\omega = K/T$ followed by a servomechanism of time constant T_1.

To obtain the calculated frequency response of the Askania controller, its transfer function is written in a third manner:

$$G(s) = \frac{K}{Ts} \cdot \frac{1 + Ts}{1 + T_1 s}$$

Substituting $s = j\omega$, and plotting, gives the frequency response shown in *Fig.* 5.

For low frequencies, the action is purely integral. If continued, the curve would cross zero db axis at $\omega = K/T$. However, at $\omega = 1/T$, the curve flattens and between that frequency and $\omega = 1/T_1$, the action is purely proportional. Above $\omega = 1/T_1$, the gain again decreases. The phase shift would likewise follow that of *Fig.* 5.

The transfer function of the Askania controller was developed from a group of differential equations based on linearizing certain characteristics of the controller. Thus, the actual frequency response of the controller obtained experimentally, although it agrees remarkably well in shape of curve, does indicate a small difference between calculated and experimental "break points" (points of slope change). This frequency response is shown in *Fig.* 8. Close agreement between the experimental evidence presented in *Fig.* 8 and desired frequency response as shown in *Fig.* 5 is apparent.

The Askania Hydraulic Stabilizer placed in an integral controller, the Askania Jet-Pipe Regulator, reduces phase shift over a significant band of frequencies and thus can be used to stabilize an otherwise unstable system comprised of controller and plant to be controlled.

The author wishes to acknowledge the contribution of K. Kubota of Nihon Regulator Co., Japan, in establishing the block diagram for the Askania Hydraulic Stabilizer, and for supplying the frequency response of *Fig.* 8.

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IMPROVED PRODUCTION CLEANING

AUTOMATIC handling equipment moves a variety of parts through cleaning processes at the Hoover Co., North Canton, Ohio. The cleaning processes involved are not new but have been used with manual handling or manual control of parts movement in many plants. Parts are immersed in boiling trichlorethylene, immersed in a cool rinse, and/or subjected to vapor cleaning and drying. By applying automatic handling to their cleaning operation, Hoover has obtained more uniform cleaning cycles and a reduction in solvent costs.

A very wide range of production parts can be cleaned in the system. Parts for vacuum cleaners and electric irons, made from aluminum tubing, steel tubing or plastics, are loaded into wire-mesh containers as they leave previous operations. The parts are cleaned without removal from the containers, which carry them through the cleaning processes.

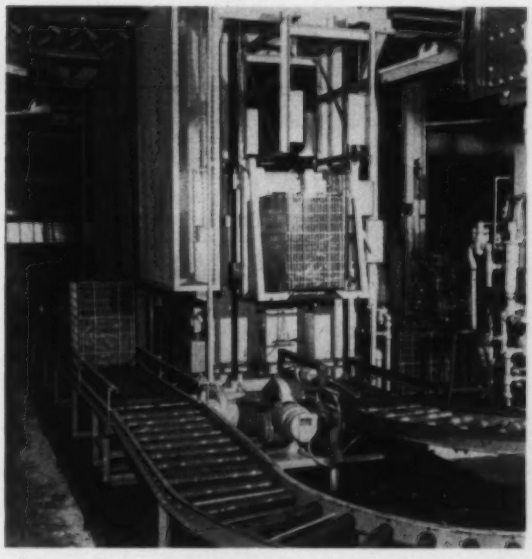
Soils removed include castor oil lubricant, chips, and miscellaneous shop dirt. Cleaning is performed after machining and, for metal parts, prior to heat treating, inspection or anodizing. When vapor cleaning alone is adequate, a selector switch can be turned and the immersion phases bypassed.

Containers loaded with parts to be cleaned approach the cleaning installation on a gravity roller conveyor. Between the roller conveyor and the carriage which lifts them to the entrance of the cleaning chamber, *Fig.* 1, is a short section of belt conveyor which operates intermittently under the control of limit switches and spaces the containers so that rise of the elevator affects only one container at a time. Hydraulically powered indexing equipment moves the container from the elevating carriage, through the cleaning processes, and out onto a second carriage at the discharge end. Use of a hydraulically powered system through the cleaner eliminates chain and sprocket maintenance and reduces ceiling height requirements for an installation of a given capacity.

The container is lowered by the discharge elevator, *Fig.* 2, and a horizontal ram slides the container onto a second gravity roller conveyor. The clean parts are then ready for succeeding operations.

Detrex Chemical Industries Inc. supplied this degreaser with a still which is operated continuously. As a result, the only appreciable maintenance required on the cleaning chamber is cleanout at two-month intervals. The cleaning installation has been operated 80 or more hours per week for many months.

Fig. 1—Variety of parts to be cleaned move in wire mesh containers to the elevating carriage shown lifting a container to the degreaser entrance. A container of cleaned parts is shown returning along the side of the unit.



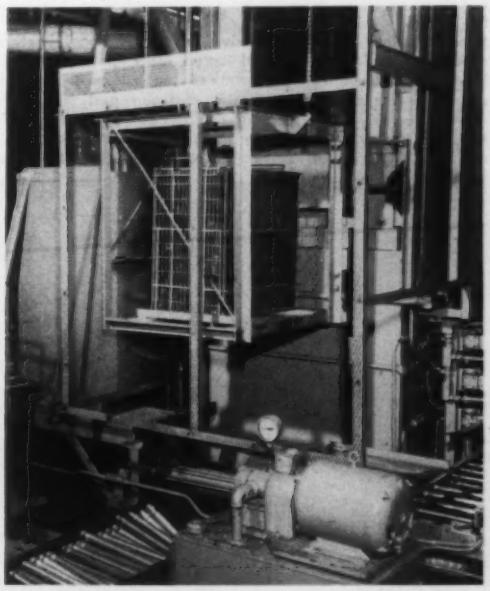
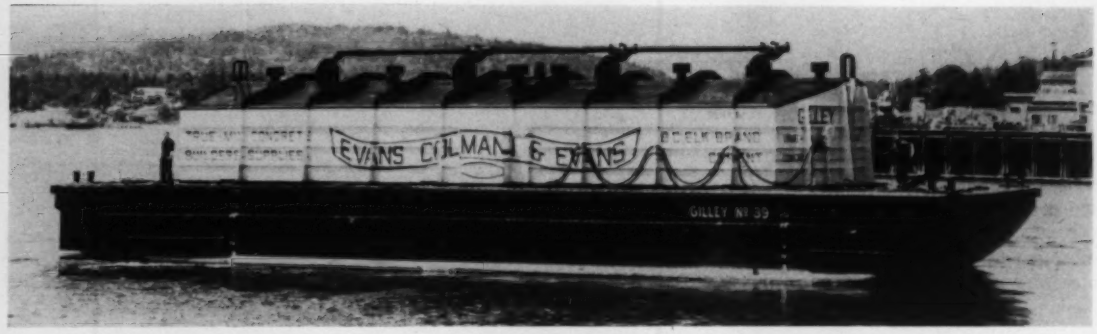


Fig. 2—Guard screens were removed for this photograph showing the discharge carriage lowering a container of clean parts. When the carriage reaches its bottom position, a pusher slides the container off the carriage.

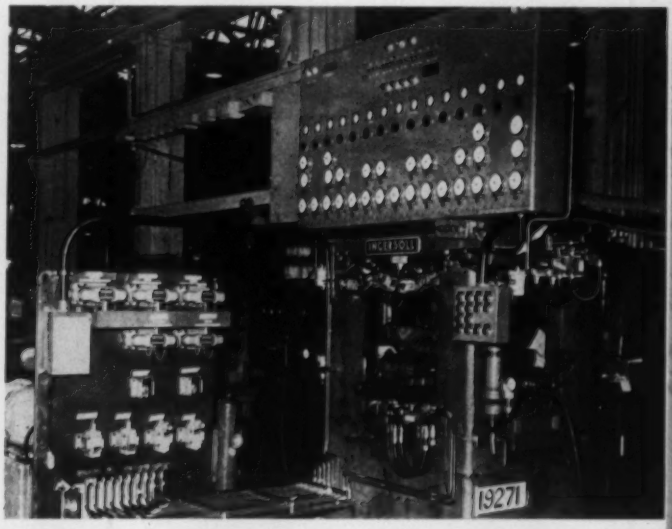


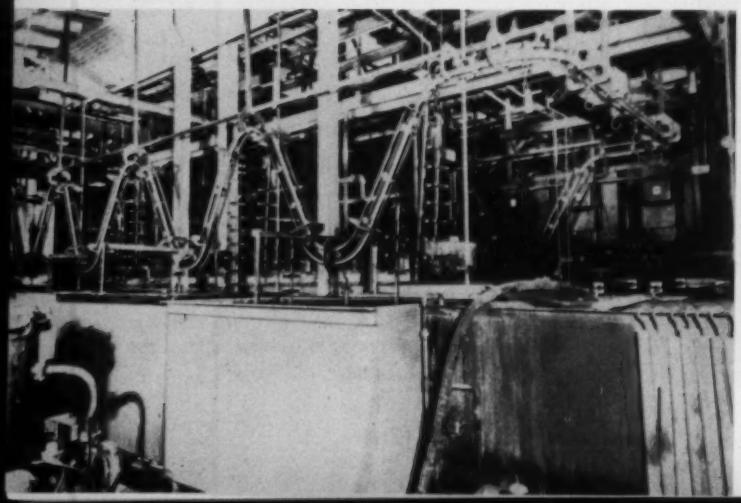
Cement Pump Aboard

SELF-UNLOADING cement barge has been constructed by Yarrows Ltd. The barge is completely self-contained with all loading and unloading facilities on board. The 105-ft long barge can carry 4500 barrels of cement and can be unloaded at the rate of 450 to 600 barrels per hour. Cement is stowed in four V-bottomed hoppers, and pneumatically loaded through an 8-inch transport line by means of a Fuller-Kinyon stationary pump. The bottom of each hopper is fitted with an F-K Airslide Fluidizing conveyor. In unloading operations, cement from the conveyor is transferred to the main pump from any quadrant, enabling an operator to control the trim and heel of the barge. A single-stage, 150-hp Fuller Co. rotary compressor provides air at 30 psi to the aerating chamber of the pump as cement is pumped through the discharge line to shore storage.

Machine and Assembly Gaging

GAGING equipment supplied by Federal Products Corp. has been combined with handling, positioning and control equipment manufactured by the Ingersoll Milling Machine Co. in establishing a gaging station for an engine block transfer line. A total of 20 inside diameters, two each in five crankshaft bores and two in each in five camshaft bores, are measured. In addition, the alignment of all oil holes in the five bearing liners are checked for alignment with the oil holes in the camshaft bores. All of these conditions are inspected simultaneously. Signal lights give a visual indication of the condition of the engine block. If all 20 diameters and the alignment of the oil holes are within tolerance, a green light indicates that the part is good. A stamping unit then stamps a plus or minus sign on each end of the block to indicate whether the number one crankshaft and the number five crankshaft bores are above or below the nominal size within the tolerance limits. Parts which are outside the tolerance limits are shunted out of the transfer line unstamped. Equipment is capable of handling 95 engine blocks an hour and does not interfere with production capacity of the transfer machine.



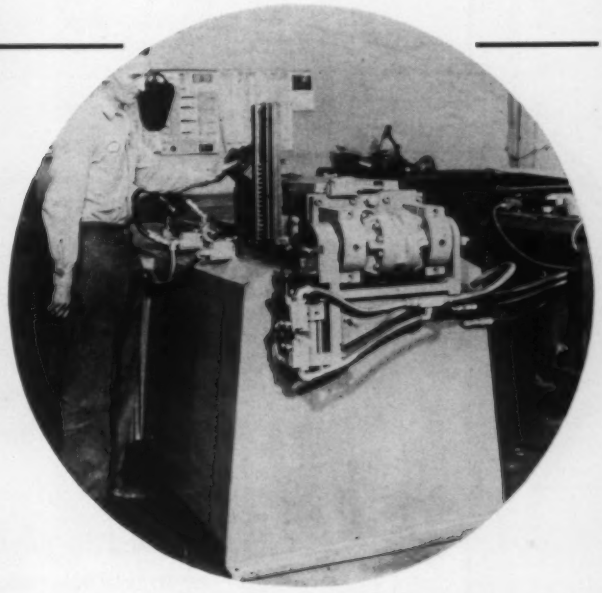


Short-Turn Conveyor

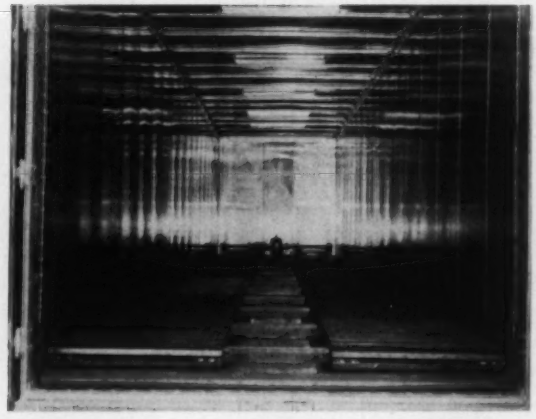
UNUSUAL FLEXIBILITY which can be built into conveyors of certain types is exemplified by installation at the D. L. Auld Co., producers of metal emblems, name plates and similar parts. The conveyor, manufactured by the Landahl Conveyor Co., Div. of American MonoRail Co., consists of trolley units made of roller skate wheels spaced evenly around a cylindrical center housing. Individual trolley units are joined together by steel round connectors in a ball and socket joint which permits complete freedom of motion between trolley units. In the illustrated installation, conveyorized parts make 18 vertical turns of only 12-inch radius, and four horizontal turns of 15-inch radius in less than 80 ft of forward travel in moving parts in and out of a series of dip tanks and ovens.

in action

Tube Bending En Masse



APPROXIMATELY 1500 automobile radiator parts are produced each hour with the tube bending machine designed and built by Walter P. Hill Inc. The machine is powered by a standard Rotac torque actuator manufactured by Ex-Cell-O Corp. Cycling continuously, the machine bends 2-inch lengths of ⅜-inch OD thin-wall copper tubing 180 degrees without deforming the tube diameter. The pieces are fed into a vertical magazine and are then gravity fed to a cylinder which thrusts them horizontally into a bending die. Another cylinder, mounted on the bending die, clamps the parts. The entire die assembly, which is attached directly to the torque actuator shaft, is then rotated upward in a 180-degree arc. The part is automatically ejected on the downward arc and the cycle repeats.

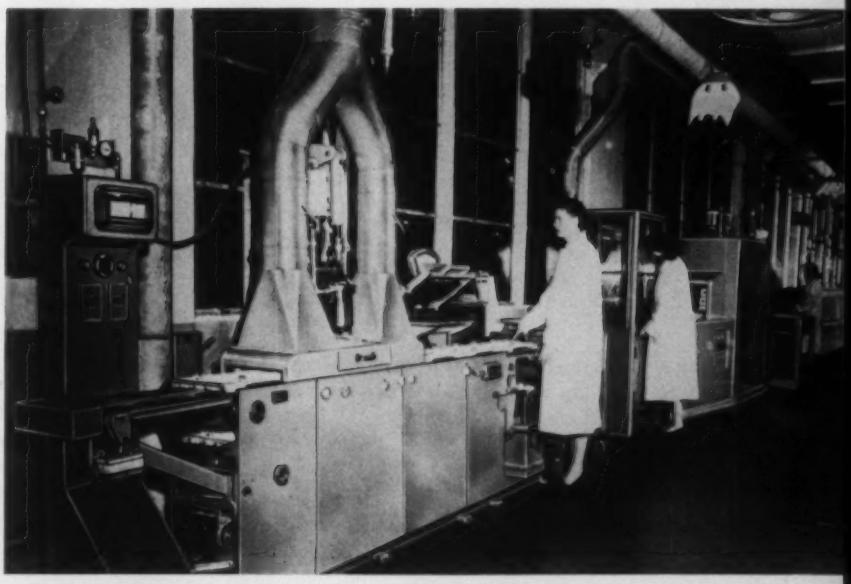


Conveyor on Wheels

LIVE BOTTOM for truck trailers consists of two slat conveyors developed by the Link-Belt Co. The unit is self-contained and can be removed when trailer is needed for more conventional forms of transportation. The technique has been applied by the American Can Co. to ship 6-oz concentrate cans to canneries. The cans were jumble-loaded into the compartmentized liner which is retracted into the trailer for shipment. At the destination, the liner is rolled out, and as it clears the tailgate, a trap door on the underside of each compartment swings open, discharging cans into a belt conveyor which carries them to the production line. The conveyor is directly connected through flexible coupling to a speed reducer powered by an electric motor which can be readily connected to power outlets at the shipping and receiving dock.

Rectifier Production Line

EQUIPMENT to manufacture a line of selenium rectifiers has been imported by the Radio Receptor Co. Inc. Machinery was manufactured by Siemens in West Germany. The 200-ft long production line manufactures rectifiers that are smaller than standard domestic types, and will make possible smaller and, in some cases, less complex electric power units. A 4 by 4-inch cell of the Siemens type will be able to replace a standard American rectifier of 5 by 6-inch cell size. The characteristics of the rectifier are obtained by careful automatic control during the manufacturing cycle. The production process and end product are unique because of three features: The type of control of the vacuum deposition of selenium, the elimination of an artificial barrier layer heretofore found necessary in selenium rectifiers, and the special thermal cycling by which the completed cell is treated after the selenium and alloy have been applied.



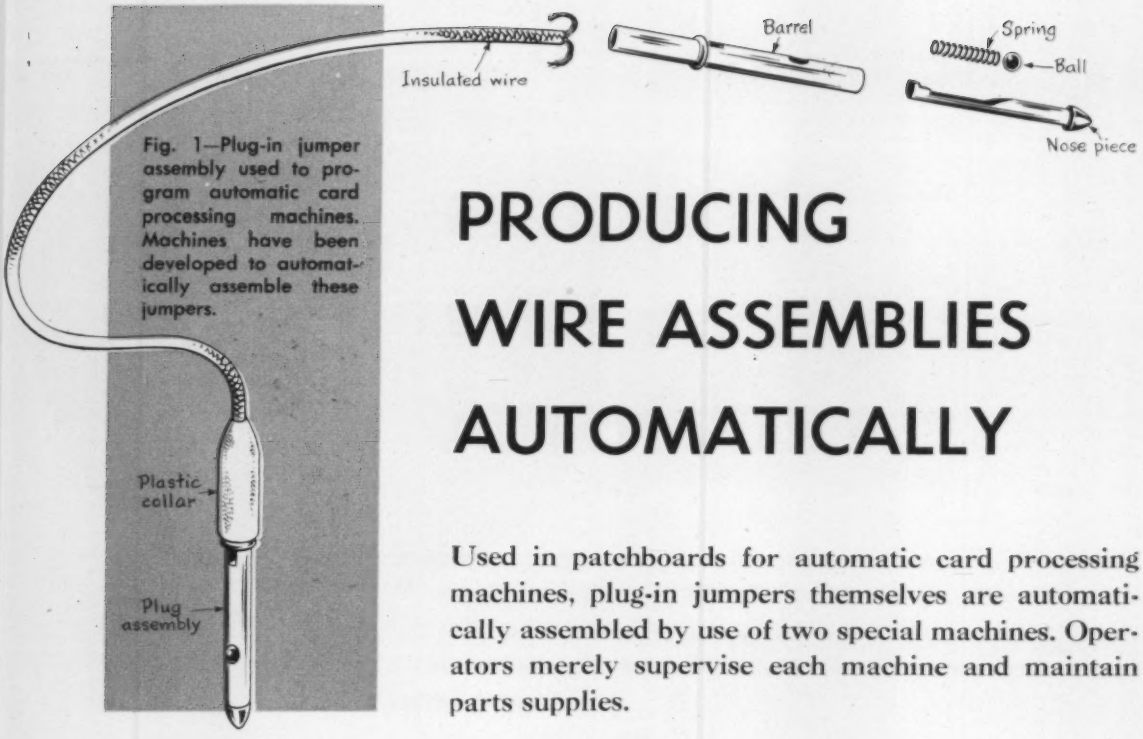


Fig. 1—Plug-in jumper assembly used to program automatic card processing machines. Machines have been developed to automatically assemble these jumpers.

PRODUCING WIRE ASSEMBLIES AUTOMATICALLY

Used in patchboards for automatic card processing machines, plug-in jumpers themselves are automatically assembled by use of two special machines. Operators merely supervise each machine and maintain parts supplies.

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AUTOMATION in one process is often helped along by automation in another process. Such is the case with many automatic card processing machines manufactured by International Business Machines Corp. Variable programs for these machines are often provided by setting up interchangeable patchboards on which selected terminals are connected through plug-in jumpers. To supply the large volumes of plug-in jumpers required, and to do so at prices which help make use of automatic card processing equipment economical, IBM has developed equipment to automatically assemble the jumpers.

The Product

Jumper assemblies involved, *Fig.* 1, are composed of ball detent plug assemblies attached to each end of an insulated copper wire, with flexible vinyl plastic collars molded over the joints between the plugs and the wire. Each plug includes a thin-walled tube or barrel of circular cross-section about 5/32-inch in diameter and 1⅛-inch long. A copper-plated die-cast nose piece slides partly into this barrel. The protruding end of this piece is cone-shaped and contacts a desired terminal on the machine when the jumper is in position in a patchboard being used on the machine. The nose piece is retained in the barrel by a tab cut in the barrel wall and bent behind a projection on the inserted end of the nose piece.

A recess, in the ¾-inch section of the nose piece which slides into the barrel, receives a spring and ball in such a manner that the pressure of the spring urges the ball up a ramp in the recess and causes it to protrude through a hole in the barrel. The diameter of the hole is small enough, however, so that the ball cannot pass through the barrel wall. When the plug is inserted in the patchboard, the spring-loaded ball can be depressed sufficiently to pass through the board. The ball again projects through the barrel after passing through the patchboard. Because of the ramp, the nose piece must slide farther out of the barrel to allow the ball to be depressed. When the plug has passed through the board it is thus locked so that pressure on the nose will not push the plug back out of the board.

Withdrawal of a plug from the board is accomplished by pulling on the wire which is attached

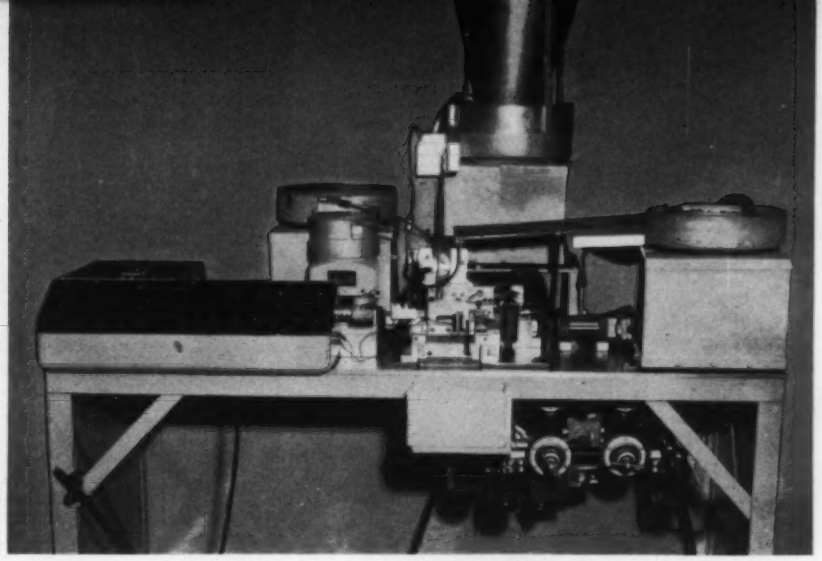


Fig. 2—Machine to automatically assemble four parts into a plug assembly. Parts are fed from Syntron feeders. The operator only supervises performance and keeps feeders supplied.

to the plug. This wire is an insulated copper wire which is cut to desired length, and each end of it is stripped of insulation, folded back on itself, inserted 3/8-inch into the open end of a plug assembly, and crimped in place. A plastic collar about 9/16-inch long is molded in place over the junction of the barrel and wire to strengthen the joint; it covers about 5/16-inch of the barrel length.

▸ Plug Assembly Machine

Illustrated in *Figs.* 2 and 3 is a machine developed to automatically assemble the four parts of the plug at a rate of 120 assemblies per minute. Barrels, nose pieces, springs and balls are fed from separate Syntron bowl feeders and oriented for proper end up and proper angular position where necessary. One operator is required to supervise the machine and keep the feeders supplied.

Barrels are fed into recesses on a wheel which indexes about a horizontal axis, *Fig.* 4. Nose pieces are fed one at a time to a carrier operated by two solenoid controlled pneumatic cylinders. The main cylinder moves the nose piece partly into a barrel and the movement of the nose carrier is stopped by the second air cylinder or interposer. Springs are fed to a transfer mechanism which positions one spring at a time in front of a plunger which feeds one ball per cycle. When the interposer stops the nose carrier, a blast of air presses the nose piece against the carrier, and the ball plunger pushes the spring and ball into the recess in the nose piece. The interposer then retracts so that the main cylinder completes its stroke and positions the nose piece, spring and ball in the barrel. The tab that locks the assembly together is then depressed and the assembly discharged from the machine.

In operation, proper feeding of barrels to recesses in the barrel wheel is checked by a limit switch that stops the machine if a barrel is missing. The machine starts from rest with the main cylinder plunger holding two switches tripped. One switch is connected with the full cycle stop button on the control panel; the other advances the main cylinder plunger. When the start button is pressed, the main cylinder plunger and the interposer plunger are advanced. The main cylinder plunger is stopped by the interposer and trips a switch that sends the spring transfer forward. This transfer trips a switch at full forward position and advances the ball plunger which pushes the spring and ball into the recess in the nose piece.

Fig. 3—Close-up from different angle shows more of the details of the machine in *Fig.* 2. Air operated assembly mechanisms are electrically controlled.

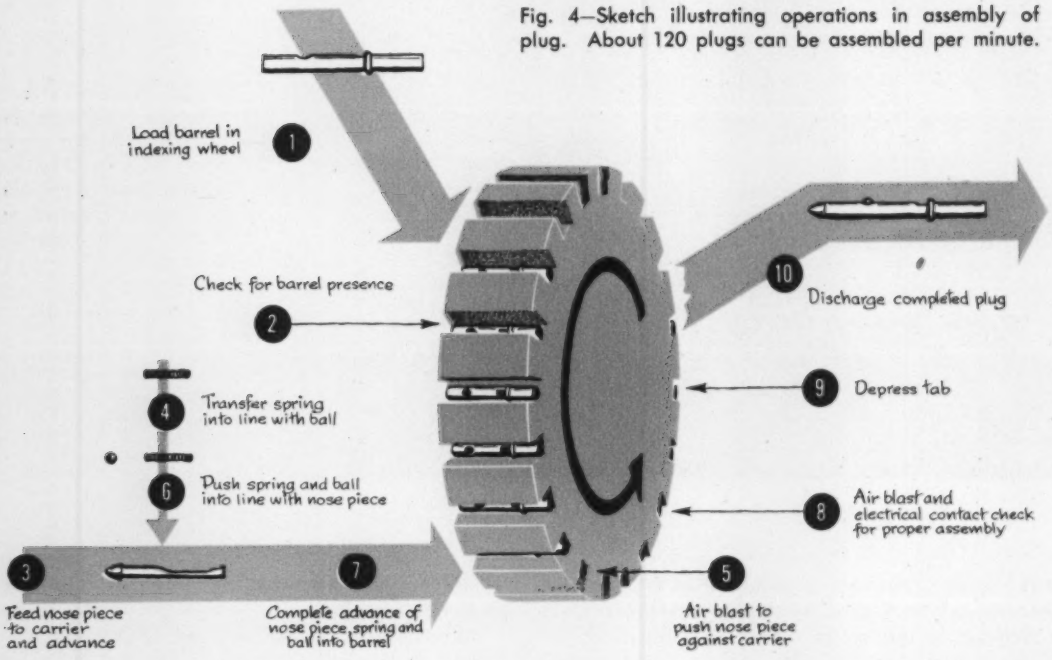


Fig. 4—Sketch illustrating operations in assembly of plug. About 120 plugs can be assembled per minute.

When the ball plunger reaches the end of its stroke a switch is actuated that sends the interposer, transfer and ball plungers back to their initial positions. With the interposer retracted, the main cylinder plunger completes its stroke. Fully extended, this plunger trips a switch which returns it to its rest position. The barrel wheel then indexes, and a second air blast checks the insertion of the spring and ball. Without a spring or ball in place in the nose piece, the air blast will move the nose piece against a contact and the machine will stop and a "part check" light will flash on a panel. After the locking tab is depressed in the barrel, the assembly drops out of the machine into a container.

▶ Assembling Plugs and Wire

Assembly of plugs to each end of specified lengths of wire was once done in special fixtures that were hand operated; later was done in special machines fed by hand; and now is performed automatically in an 8-station rotary indexing machine, *Figs.* 5 and 6. This machine takes wire from a reel, feeds plugs from a Syntron feeder, and feeds vinyl compound from a hopper to produce about 19 complete jumper assemblies per minute.

Operation of this machine can be outlined as follows. At the first station, wire is pulled from a reel, passed through a U-shaped slot and cut off. Feed rolls measure out the specified length, and the length of jumper produced can be varied by changing setup of the feed rolls. The two cutoff ends of the wire project from a guide and gripper about 1-1/16 inch.

After the table is indexed to the second station, the loop of the wire is drawn tight around an anvil and stripping knives close on the wire ends. These knives are pulled out from the anvil and strip the

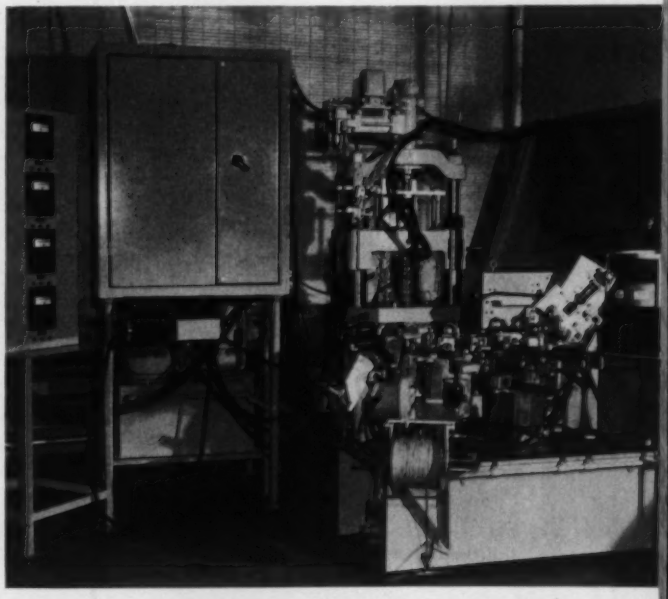


Fig. 5—Rotary indexing machine, which automatically assembles plug-in jumpers, is supplied with a reel of wire, plug assemblies, and plastic molding material.

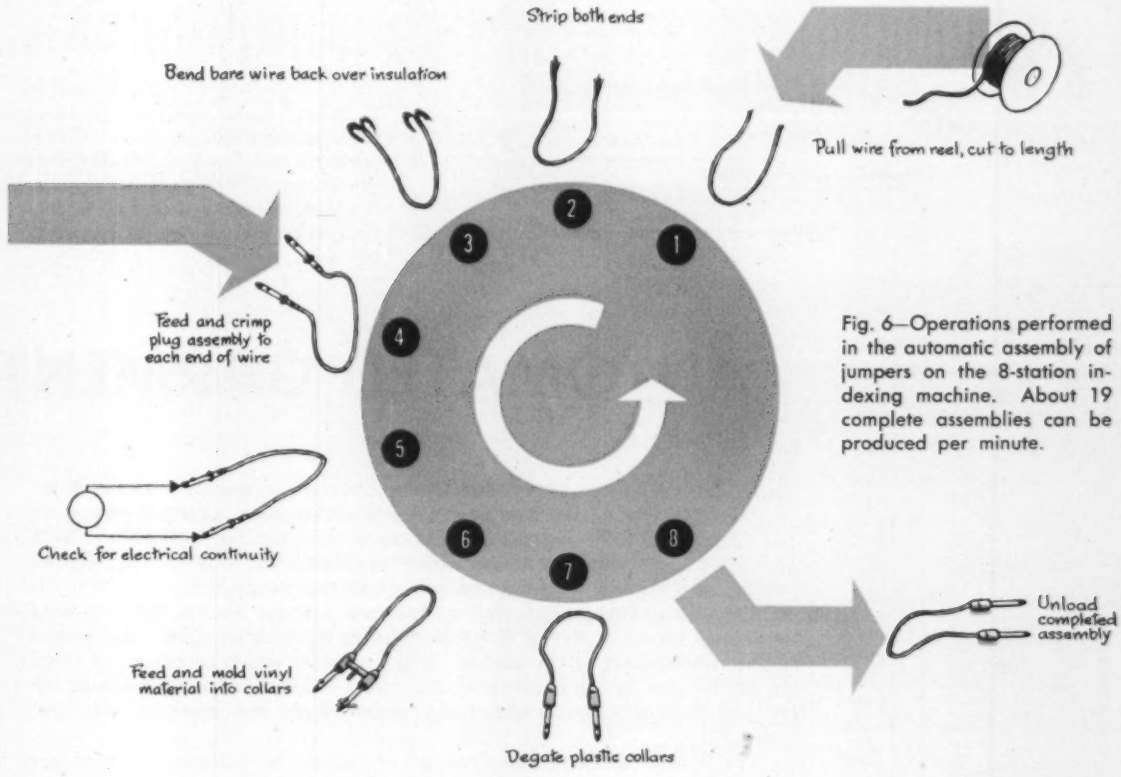


Fig. 6—Operations performed in the automatic assembly of jumpers on the 8-station indexing machine. About 19 complete assemblies can be produced per minute.

insulation from a specified area at each end of the wire. In two steps at the third station, plungers bend the stripped ends back 180 degrees, leaving the strands pressed against the outside of the insulation.

At the fourth station, plug assemblies are fed from a Syntron hopper to two magazines. Plugs are fed from these magazines into a pair of recesses where an arm pushes the open ends of the plugs over about $\frac{3}{8}$-inch of the wire ends. Crimpers then automatically compress the barrel around the wire. An electrical continuity check is made at the fifth station. If a break is detected, the machine is stopped automatically and the imperfect assembly is scrapped. Inspection at this point eliminates bad assemblies so that no further operations are wasted on them.

Assemblies that pass this check are indexed to the sixth station where the joints at each end of the jumper are positioned in connected cavities of a molding die. The die is closed and heated vinyl plastic is injected to form collars around each joint. A standard 5-ton injection molding press is used for the molding operation. When the plunger of the press reaches the end of its stroke, a limit switch is closed and starts a timer. At the end of the preset time interval, the plunger is retracted and the injection cylinder is elevated. This action shears off the plastic where the sprue enters the die, and the die is then opened.

The assembly, with collars molded in place, is then indexed to the seventh station where the runners are sheared off. Cutoff occurs where the runners meet the collars, leaving only small spots showing. Material cut off is reused by mixing it with the new plastic material fed to the molding unit. Operations on the assembly are then complete and it is ejected at the eighth station. After the assembly is discharged, a wiper is moved automatically through the gripper jaws to clean them in preparation for the next cycle.

One operator is required to attend the machine. He keeps a supply of plastic material in the hopper that feeds the injection cylinder, using the runners sheared off at the seventh station plus new granular material. He also puts reels of wire in place as needed and checks machine performance. If faulty functioning occurs the machine stops automatically, and the operator is trained to spot troubles and correct them, with the help of setup men or others if needed.

▶ Operation Improvements

The machines described have effected large savings in direct labor costs per unit produced. In addition, the assemblies produced are superior to those produced by manual methods. Workers formerly engaged in the tedious manual performance of the assembly operations have now been assigned to other work.

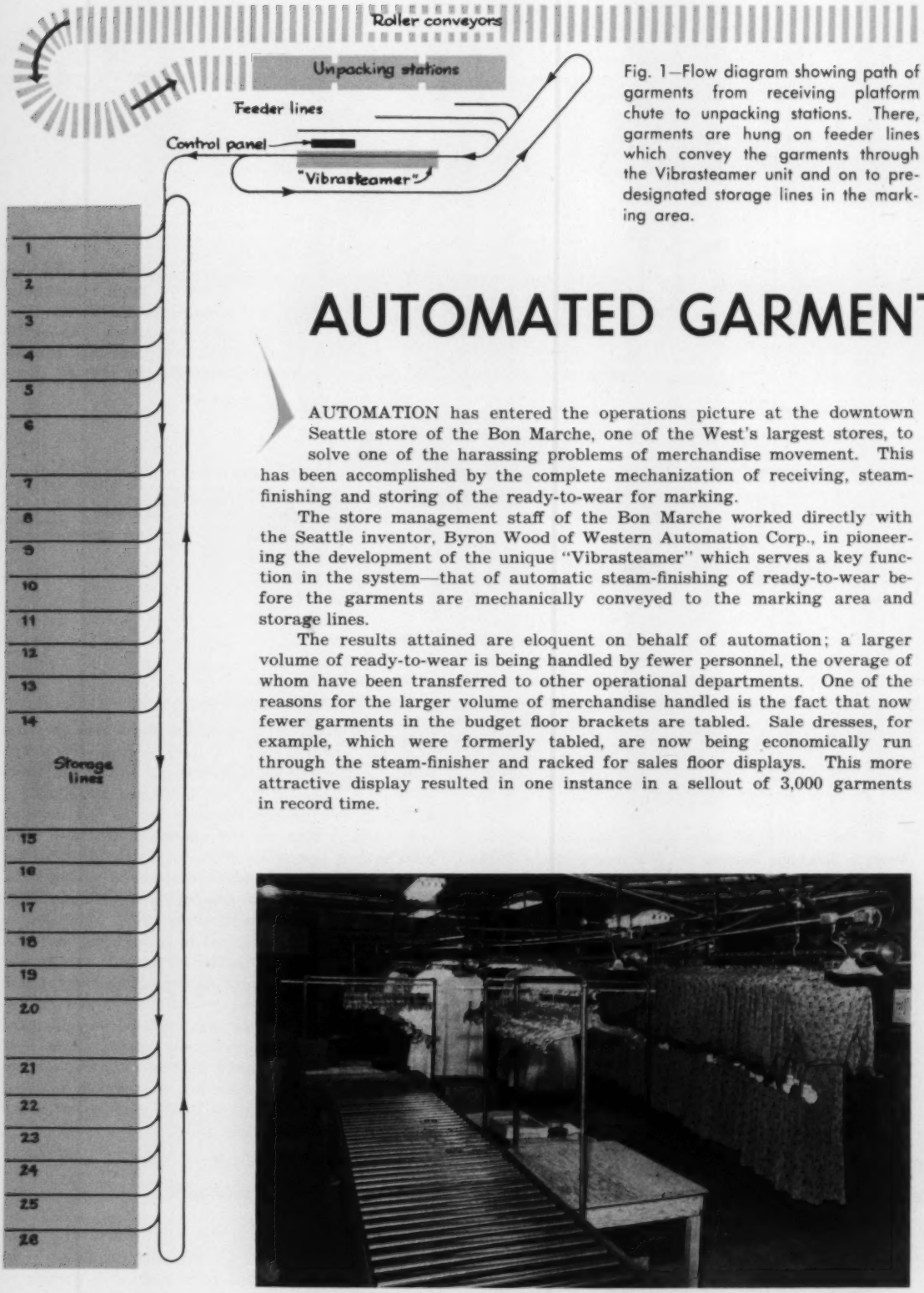


Fig. 1—Flow diagram showing path of garments from receiving platform chute to unpacking stations. There, garments are hung on feeder lines which convey the garments through the Vibrasteamer unit and on to predesignated storage lines in the marking area.

AUTOMATED GARMENT

AUTOMATION has entered the operations picture at the downtown Seattle store of the Bon Marche, one of the West's largest stores, to solve one of the harassing problems of merchandise movement. This has been accomplished by the complete mechanization of receiving, steam-finishing and storing of the ready-to-wear for marking.

The store management staff of the Bon Marche worked directly with the Seattle inventor, Byron Wood of Western Automation Corp., in pioneering the development of the unique "Vibrasteamer" which serves a key function in the system—that of automatic steam-finishing of ready-to-wear before the garments are mechanically conveyed to the marking area and storage lines.

The results attained are eloquent on behalf of automation; a larger volume of ready-to-wear is being handled by fewer personnel, the overage of whom have been transferred to other operational departments. One of the reasons for the larger volume of merchandise handled is the fact that now fewer garments in the budget floor brackets are tabled. Sale dresses, for example, which were formerly tabled, are now being economically run through the steam-finisher and racked for sales floor displays. This more attractive display resulted in one instance in a sellout of 3,000 garments in record time.

Fig. 2—View of a typical unpacking station. Garments are removed manually from shipping cartons. As they are hung, the conveyor automatically moves them forward to make room for the next garment. Feeder lines convey them in planned sequence to the Vibrasteamer unit.

Automation enters many fields, and often provides unexpected benefits in addition to those originally needed to justify it. In this application to garment merchandising, goods received by the retailer are steam-conditioned and automatically routed to marking stations.

FINISHING

The situation where a larger volume of production is handled with greater efficiency becomes still more attractive when it is considered that the entire installation will be amortized in two and a half years, according to the Bon Marche management.

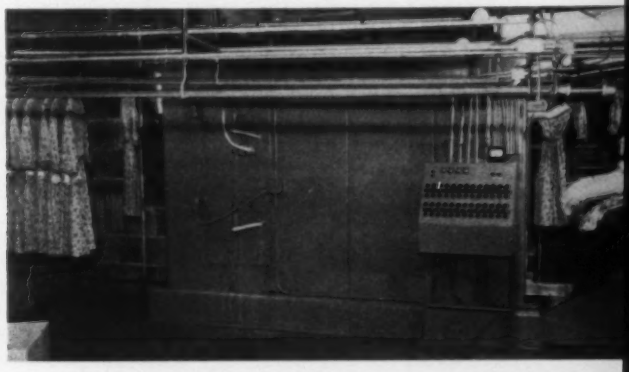


Fig. 3—Garments shown entering the Vibrasteamer unit will be steam-conditioned and vibration-pressed. The control panel on the right sets steaming conditions and determines the storage line to which the garments will be routed after leaving the unit.

▸ Operation

The operation calls for a continuous flow of garments to the markers, *Fig.* 1, with the initial link in the system in the spiral chute extending from the receiving platform concourse to the sub-basement. The chute has a 42″ wide bed, and handles shipping cartons of any usual dimensions.

Cartons chuted to the sub-basement steaming and marking area are conveyed by gravity roller conveyor to the unpacking stations, *Fig.* 2, where operators, one at each station, lift the garments out of the cartons and hang them on overhead feed conveyors. As the garments are hung, the conveyor automatically moves them forward to make room for the next garment. The feeder conveyors may be filled to capacity—as many as 280 garments—or any specific lesser number may be fed to any given conveyor, according to the size of the order or the ultimate departmental destination. When the operator is ready to send the garments through the Vibrasteamer, a switch controls the feeder conveyor.

As the switch is pulled to feed garments from the feeder conveyor to the Vibrasteamer conveyor, the garments automatically are turned edgewise by guide strips, then conveyed into the steam section, where solenoid actuated steam valves, operated by photoelectric cells, automatically apply steam according to the length of the garments.

Dial controls on the Vibrasteamer, *Fig.* 3, permit the operator to set the steaming unit according to the type and fabric of the garments. Synthetics, woolens, cottons, silks, etc., all require different settings. The type of garment and the material determine the time elapsed from unpacking to marking area storage line, with as many as 12 garments per minute being processed. Switch positions on the panel select the marking area storage line desired, to which the completed garments are conveyed automatically as they leave the steam-finishing cabinet. From steaming, the garments are conveyed into the warm air chamber, where vibration occurs to put an automatic press-like finish on the steam-conditioned garments.

As the garments are conveyed out of the Vibrasteamer, they pass through inflated upright air lock rollers of soft material, directly on to the marking area storage lines, *Fig.* 4, as predesignated departmentally on the Vibrasteamer control panel. There is a gravity decline from the main conveyor to the 26 storage lines which accommodate 5,000 garments.

▸ Safety Provisions

A point of interest, as noted throughout the installation, is the automatic control to avoid pile-ups at any stage of the process. For example, in the use of three different unpacking stations at the start of the system, three different orders can be hung at one time, any one of which may be Vibrasteamed in any desired sequence. An order for a department with a big sale, for instance, might have priority in going through the steam-finishing cabinet; an interlocking device placed in the control circuit prevents more than one feeder conveyor from operating at a time, thereby eliminating any possibility of orders being mixed.

It has already been noted how the installation is set up to automatically convey the garments to

the marking area via the control panel on the Vibrasteamer. When an order is completed or when the storage line in the marking area is full, the switch mechanism automatically stops the storage line from operating, or diverts the garments to the next storage line.

Benefits

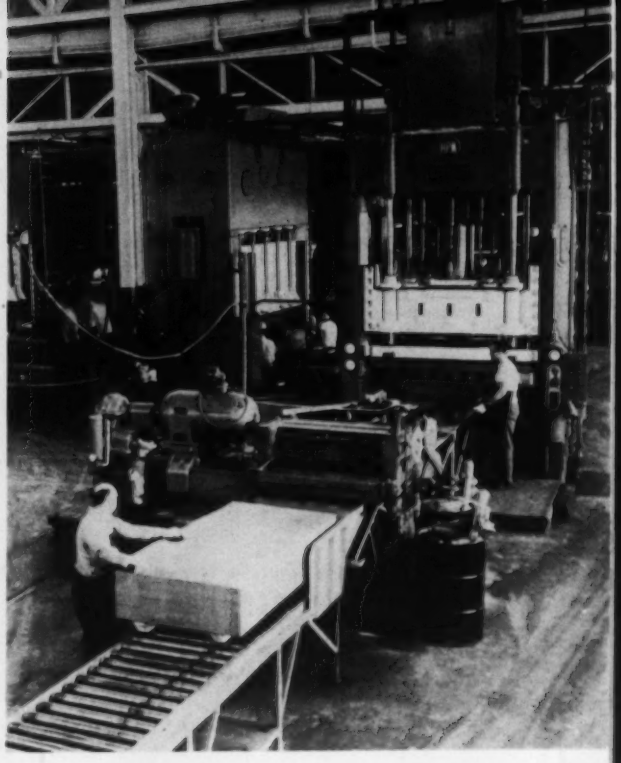
It has been stated that the Vibrasteamer serves a key function in the overall mechanization applied to steam-finishing and storing for marking, and this is definitely established as the dry, display-ready garments leave the cabinet in a continuous flow, without condensation marks or spots. Special mention should be made of the way the garments look; they are fresh, crisp and wrinkle-free from neckline to hem.

Some additional advantages of the installation are: the ability to process garments without steam, employing only the automated sorting and storage facilities; the controlled steaming available for different fabrics, which eliminates the dangers of oversteaming and drenching; also, the standardized volume of steam applied under normal operating conditions which results in conservation of the store's steam supply.

Installed to take the place of laborious hand-steaming of ready-to-wear prior to putting on the sales floor, the Bon Marche's new automation system has been found to have a number of by-product advantages in addition to the factors already outlined. One of these is easier marking. Alternate rows of garments may be automatically turned so that marking done in one aisle will allow marking the price on left or right sleeves only, when required. Wider aisles which are provided with this installation also make for easier and more efficient procedures in the marking area.

Stepped-up efficiency in all phases of ready-to-wear handling, with a plus of customer satisfaction with the automatically steam-finished ready-to-wear, are the direct results of automation at the Bon Marche.

Fig. 4—Final destination of the garments is the storage area shown. Garments have been automatically sorted and are ready for marking.



AUTOMATION

By H. R. NEIGHBOURS
Manager, Plant Engineering, Whirlpool-Seeger Corporation, Marion, Ohio

CABINETS for home laundry dryers of Sears-Kenmore and Whirlpool brands are major products of the new Marion, Ohio, plant of the Whirlpool-Seeger Corp. As the plant was laid out and newly equipped especially for this job, and with the intention of using as much automation as seemed expedient, it is not surprising that, even in initial stages, five men can do as much as thirteen in the older setup. This applies to the line for only one stamping; namely the three-sided "shroud" that is the largest component of the cabinet.

Final Objective

The objective is to run this entire line ultimately with one man, but whether this will prove feasible remains to be seen. Attainment of this goal will require, of course, that all automation units be developed to a point where functioning is highly reliable. Presses themselves are less of a problem, as each readily can be made to perform its functions automatically. Automatic loading and unloading with perfectly interlocked timing present more problems.

Mere forming of a sheet into a three-sided rec-

Fig. 1—General view of the start of the line on which shrouds for dryer housings are produced. Leveling rolls in foreground feed blanks to first press that draws the door recess and pierces and flanges the large central hole in shroud.

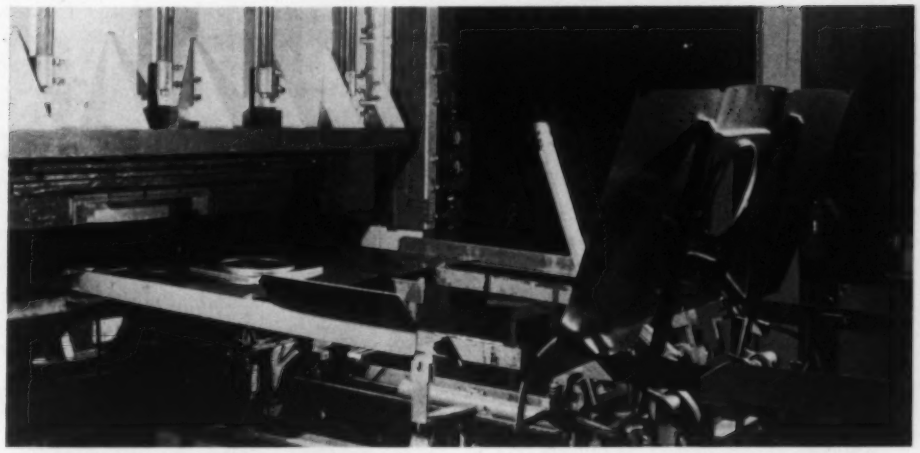


Fig. 2—Trimmed parts leaving the second press are inverted before being fed to the flanging press, next in line.

AIDS STEEL CABINET FORMING

Automation is particularly applicable to large press operations, and here a plant making laundry dryer cabinets gives an interim report on progress toward that end.

tangular cabinet is relatively simple, but when the front, constituting the middle panel, includes a square door recess having a drawn flange around a central hole, as in the case dealt with here, the problem becomes more complex. This is accomplished on a 300-ton HPM hydraulic press which can make the draw readily and consistently without tearing, wrinkling or other injury to the stamping, with the uniform precision and good surface finish desired. An important factor making for good drawing is to have pressure applied by the four hydraulic cylinders that control the blank holder so adjusted as to insure just the right metal flow during the draw.

▶ Drawing

Production starts by loading pre-cut bundles of blanks on the roller conveyor shown in the foreground, *Fig.* 1, using a 15-ton overhead crane. Before drawing, the blanks, now fed by hand, are passed through McKay leveling rolls from which they issue onto the roller table at die height in front of the HPM press. Feeding the blank to a stop and tripping of this press are now done by hand, but procurement of automatic equipment is planned. Application of draw compound on the area to be drawn is already done automatically by timed spray guns.

The next press operates the die that performs the rough draw and pierce operations in one stroke. Discharge of the drawn part is by hand but will be automatic, as will also the discharge of the circle trimmed out. As only the central portion of the blank is formed, the blank can be fed parallel to its length and can overlap the die, making it possible to use a narrower and less expensive press than would be needed if the length had to be crosswise of the press. Physical arrangement of the setup also makes such feed advantageous, as the arrangement of the next two presses requires the part to travel transverse to its length, i. e., at right angles to initial motion, hence the stamping

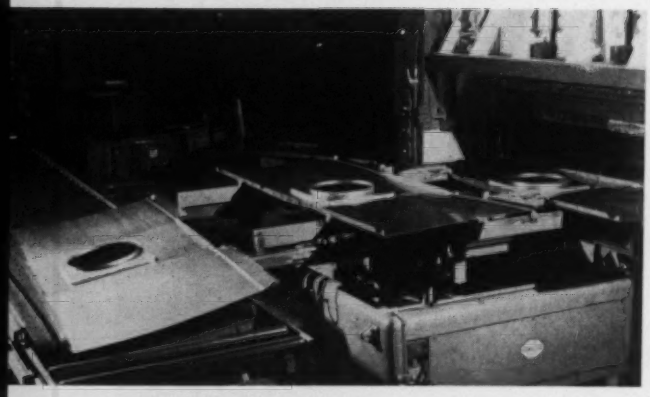


Fig. 3—Edge-flanged sheets are discharged by Hamilton Automation unit onto a transverse belt for transport into the curling press.

would have to be turned 90 degrees if feed through the HPM press was not longitudinal.

Transfer to the trim press is now by hand along a roller conveyor and feeding is done by two men because the stamping is so large. Both transfer and feeding will be automated, however, and the trim scrap, now handled manually, will be removed by belts. Withdrawal from this press, turnover, transfer and feeding to the third press already are performed by a Hamilton Automation unit, part of which appears in *Fig.* 2.

This unit pulls the trimmed part out of the trim press and lands it between arms that turn the stamping over and lower it for further advance into the flanging press, the back of which appears in *Fig.* 3. All motions on the Hamilton unit are automatic and are synchronized both with the trim press and with the flanging press, so in effect, the controls interlock the two presses and the correct sequence of motions must take place.

It is noteworthy that the entire Hamilton unit is self contained and is on casters. Thus, if the unit fails to function properly, the flexible control wires can be disconnected and the entire unit can be pushed to one side, permitting the line to continue with temporary manual handling until the difficulties are overcome and the unit can be pushed back, reconnected and start to function automatically. This arrangement also permits access to the press for die changes and for any repair work needed thereon.

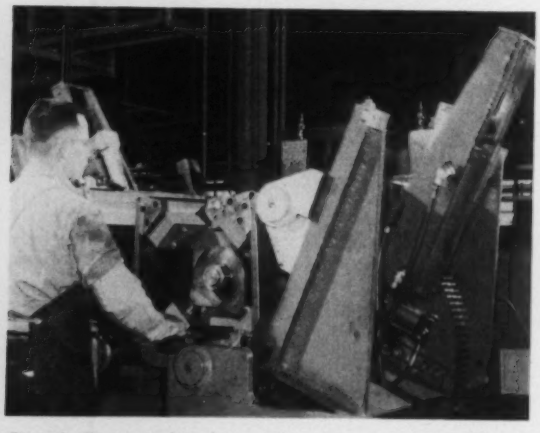


Fig. 4—Tangent bender as it appears in closed position after forming the two side panels of the shroud upward in a locked die. When the die is unlocked automatically, the operator removes the completed shroud by hand.

▸ Flanging and Curling

Besides simple flanging, the third press does an extruding operation at the central hole. Then a second Hamilton unit, *Fig.* 3, pulls the flanged piece out of the press and transfers the stamping to a wide belt for advance to the fourth press in a direction parallel to the length of the piece. This belt is arranged to drop the stamping over a die that curls the edge of the central collar. Tripping of the press occurs automatically when the stamping locates itself.

When the fourth press opens, the stamping is lifted free of the die by a second belt that carries the stamping onto rolls over which it is moved onto the outer bed of a tangent bender. Automatic handling equipment that includes the belts and the tripping mechanism of the curling press was developed in the plant but includes several purchased components.

▸ Bending

Loading into the tangent bender, *Fig.* 4, is done automatically from rolls on the outer feed bed of the machine. When the piece is properly located a start button is pressed, the work piece is clamped, and the side arms move up automatically, forming the two side panels until they are at right angles to the front face. Then the machine opens automatically and frees the formed shroud so that the operator can lift it out.

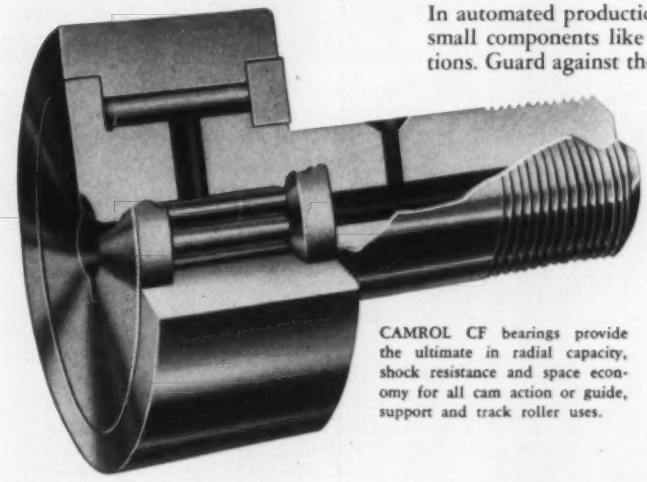
Shrouds lifted from the bender are placed on a track and are advanced along it into a special machine that pierces a hole at an angle below the top, after which the piece is released and continues along the track to a welder in which some small door hinges and other parts are spot welded in place to start the housing assembly.

From the foregoing, it will be noted that there are five men on the line. Of these, one feeds the leveling rolls, one feeds the HPM press, two unload this press and load the trim press and one removes parts from the tangent bender. These men can process 275 pieces an hour.

Improvements in efficiency and output which have been realized with the present status of automation on this line suggest even greater benefits to come when plans for further application are completed.

AUTOMATION TIPS by McGill

CAMROL TRADE MARK bearings ideally suited to anti-friction requirements of automated machinery

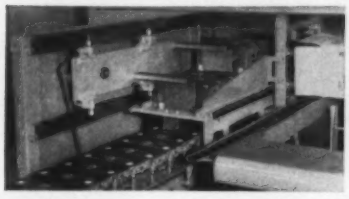


CAMROL CF bearings provide the ultimate in radial capacity, shock resistance and space economy for all cam action or guide, support and track roller uses.

In automated production, even the inefficiency and faulty operation of small components like a cam follower unit can cause costly interruptions. Guard against these failures by specifying CAMROL cam followers. Their quality insures dependability. Their design simplifies lubrication, easily accommodates critical loads and provides low starting and running friction.

Over 20 years of engineering development has gone into the McGill bearing — the first commercial full-type roller bearing cam follower. McGill has employed the advantages of these years of application experience to improve the design and build performance extras into the CAMROL CF, CYR and sealed SCF and SCYR series bearings. All are available in a wide range of standard sizes.

The applications cited below are just a few of the many instances where CAMROL bearings are adding to the dependability of automated machinery.

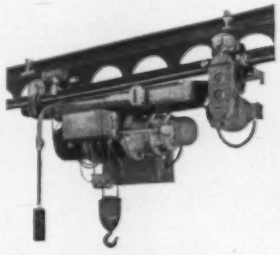


Camrol CF bearings cut power requirements on J. L. Ferguson Co. packaging machines

Used as load-carrying cam followers and as guide rollers in PACKOMATIC packaging machinery, McGill CAMROL CF bearings have brought several desirable advantages to J. L. Ferguson Company in the eight years this firm has relied on CAMROL bearings.

The CAMROL CF bearings eliminate wear by reducing friction. This reduces power requirements and smooths the operation of these machines. The CF bearings are standard, cost less and are more easily applied than previous assemblies.

For trouble-free operation, up to 50 bearings per machine are now used by this company.

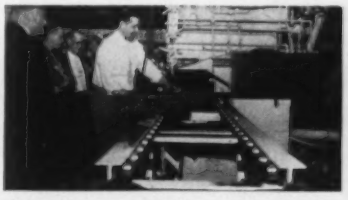


Cleveland Tram Rail guides motor heads on McGILL Camrol Bearings

Motor-driven electric hoist carriers made by the Cleveland Tramrail Division of the Cleveland Crane and Engineering Company, incorporate McGill CAMROL Cam Follower bearings as side guide rollers for the motor head.

Replacing spring loaded friction type bolt or roller units, the CAMROL cam followers provide dependable, free running operation of the carrier assembly and provide simplicity of mounting and lubrication with trouble-free performance.

Bearing performance has been most satisfactory through almost six years of use.



Camrol CF bearings provide friction-free track rollers for automatic mold blower

McGill CAMROL CF rollers are used as track rollers to form a mold conveyor in the Beardsley & Piper MBS-20 Mold Blower. The CAMROL CF bearings replaced built up friction rollers in this application. Although the duty here is rather light and the speeds slow, the cam follower bearing provides less starting and running friction. This helps speed the even flow of work from the machine, which must be fast and automatic. The compact unit, with integral stud, simplifies assembly and lubrication. Availability of a standard bearing is more convenient and less costly.

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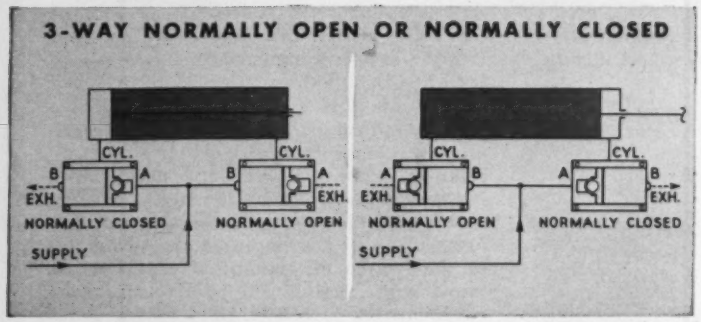
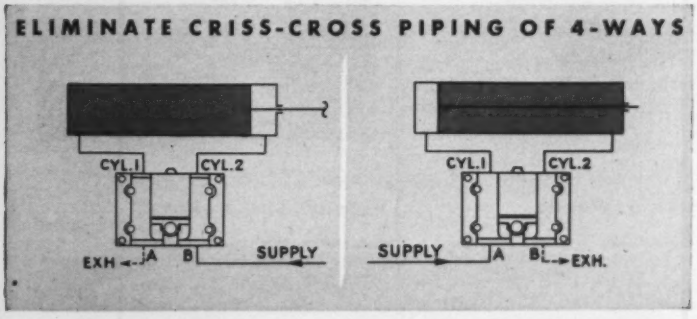


Simply pipe to proper port . . . no change in valve necessary

Piping supply to Port "A" provides Normally Closed operation — supply to Port "B" Normally Open operation. There are no changes to make in the valve . . . just pipe to the proper port. All 3-Way valves have two cylinder outlet ports for piping convenience.

The exclusive Nopak-matic "Flow-Director" pilot head automatically selects pilot pressure from whichever port is used as inlet. It eliminates purchasing special valves for each application or re-assembling of parts.



Simply pipe to proper port . . . no change in valve necessary

All Nopak-matic 4-Way valves can be piped with pressure to Port "A" or Port "B". Here again, the "Flow-Director" pilot head automatically selects pilot pressure from the inlet port. Flow through the valve is thus changed to meet the application requirements . . . eliminates criss-cross piping to the cylinder. There are no changes to make in the valve . . . just pipe to the proper port.

NOPAK-MATIC Plus Value Valves are available in ¼", ⅜", ½" and ¾" pipe sizes, for 2- or 3-Way Normally Open or Normally Closed operation with master (air), single or double solenoid pilot control heads.

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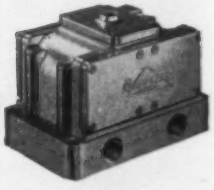

400 SERIES
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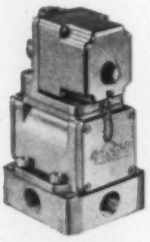

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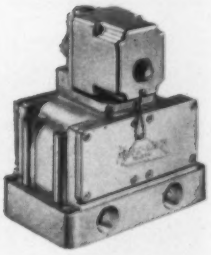

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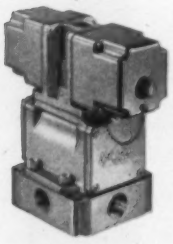

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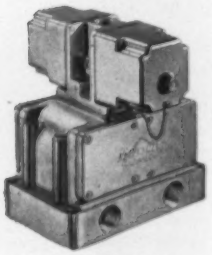

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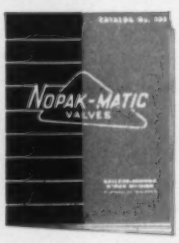

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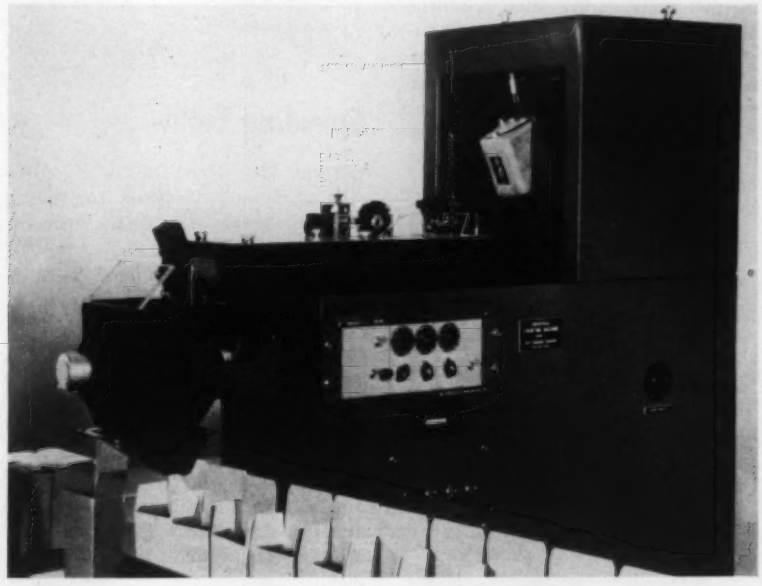


High-Speed Automatic Counting Machine

Item 401—Increasing demand for automated equipment to count and batch discrete items — equipment which can be integrated into continuous process lines—has led to the development of a line of such machines by **Delta Engineering Corp.**, 126 W. Emerson St., Melrose 76, Mass. Flexibility has been the design keynote of their universal counting machines, built for high speed, accurate counting of a wide variety of small objects. The machines may be changed over from one product to another without additional guides, counting instruments or other equipment.

Operation

In operation, desired batch quantities are set on a preset counter and the objects to be counted are placed in the machine's hopper. The machine automatically orients the products being handled and feeds them past a photoelectric transducer which, coupled with the counting instrument, registers the actual count.

After the preset count is reached, the instrument energizes an electrical circuit which is employed to sequence the batching device, dividing the products into the preset quantity and releasing them from the machine as a group. Subsequently, wrapping machines and box-filling conveyors are used to package these groups of products. This phase of the operation is synchronized and controlled by a standard unit in the counting machine, making possible the counting and packaging all in one automatic operation.

Counter Selection

In order to achieve the necessary flexibility in operation of the universal counting machine, Delta engineers concentrated principally on selection of a suitable preset counting device. Since many of the objects to be counted are extremely small, a tiny light beam, 1/32-inch in diameter, had to be used. This specification in turn posed unusually rigid sensitivity requirements on the counter due to the resulting low output signal from the photodiode.

Other applications called for a much larger light beam, making it necessary to pick an instrument which would be reliable for both low and high output signals from the photodiode. Additional considerations required that the counter be relatively unaffected by ambient light levels and line voltage fluctuations.

A number of preset counters were considered and several were subjected to operational test in prototype machines. After test results were evaluated, Delta decided on electronic count control using a preset counter manufactured by **Baird-Atomic, Inc.**, 84 Massachusetts Ave., Cambridge 39, Mass.

This counter utilizes special cold-cathode electron tubes which feature long life and reliability over extended periods. Several of these Dekatron glow decade tubes are used in a preset counter. Within each tube, a red luminescent spot successively indicates the ten digits, 1 through 0, inscribed in a ring around the outside of the tube. A series of electrical impulses derived from the series of events to be counted is applied to the first tube. This causes its glow to move around the ring, advancing one digit for each impulse.

When the glow has completed its transit of 10 digits, it sends a pulse to the second tube, advancing its glow by one digit. When the glow in the second tube has completed its transit of 10 digits,

*For Inquiry Card, see page 17

one pulse is sent to the third tube, advancing its glow one digit, and so on. This action is wholly electronic and input impulse rates up to 20,000 per second can be totalized.

As used in counting and control applications, the process described above actuates a relay upon reaching a predetermined count which has been set up on dials that are an integral part of the counter circuit. When the relay operates, it can motivate an external control for stopping, diverting or otherwise modifying the process line after the prechosen number of events has occurred. The counting instrument can be provided with either an automatic reset or manual reset, or both. Under automatic operation, when the external function takes place, the instrument resets itself and repeats the cycle. When on manual operation, the external function takes place, the instrument resets itself and repeats the cycle. When on manual operation, the external control takes place at the predetermined count, but reset to zero does not occur until directed to do so by electrical or mechanical means.

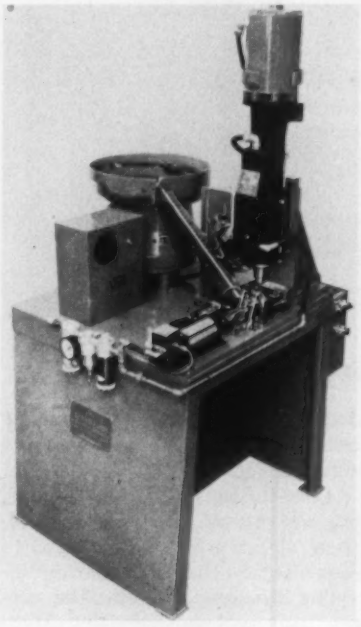
In selecting the counter, Delta engineers also considered its performance under fluctuating line voltages as might occur in customers' plants, inasmuch as such variations could affect the accuracy of the entire counting operation. The counter, with its stabilized power supply, is designed to compensate for wide variations in line voltage.

Each decade tube with its associated circuitry is mounted on an individual panel strip. These strips can be combined in banks to provide a wide variation of counting ranges. Thus, the Delta machine can be offered in counting ranges of 1 to 99, 1 to 999, etc., merely by adding unit strips. This "building-block" feature allows the customer to specify the least number of strips consistent with his requirements, thus avoiding the cost of unneeded components. Also, maintenance costs are reduced since defective strips can be readily removed for servicing. If the user prefers he may return the units to the factory for repair, thus overcoming the need for trained personnel in his plant.

Results and Expectations

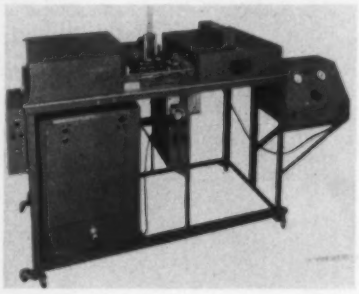
Versatility of the Baird-Atomic counter has enabled Delta to sell a number of special-purpose machines for unique applications. Recently the company delivered two multichannel machines each channel of which is equipped with a photodetector. Signals for the various detectors are fed into a memory circuit and then to the standard preset counter.

Delta foresees new markets for its machines, citing such potential applications as the counting of aircraft, electrical and military hardware items, game parts, embroidered emblems, brass fasteners and fittings, pharmaceuticals, and electrical and electronic components of all sorts.—*Circle 401.



Small Parts Tapper

Item 406—Featuring a rate of over 1500 pieces per hour, automatic tapping machine is designed to handle small parts. The machine consists of a vertical tapping unit, a vibratory feeder, a gravity track, an escapement, a work feeder which positions and clamps the part securely in the tapping fixture, and an ejector mechanism which discharges the part into a chute. The basic design of the machine may be modified to adapt it to automatic drilling or assembling. **Automation Development Corp.**, 135 Reynolds Rd., Mentor, O. —*Circle 406.



Spiraling Lathe

Item 426—Used in the production of deposited carbon and metal film resistors, spiraling lathe is designated Model SL. The equipment is hopper fed and cuts a helix on the resistor, increasing its electrical value. When the preset resistance is reached, an electronic controller automatically stops the helixing operation. This particular equipment cuts the helix on the inside of a hollow tube; models are also available for external spiraling. **Industrial Instruments Inc.**, 89 Commerce Rd., Cedar Grove, N. J.—*Circle 426.

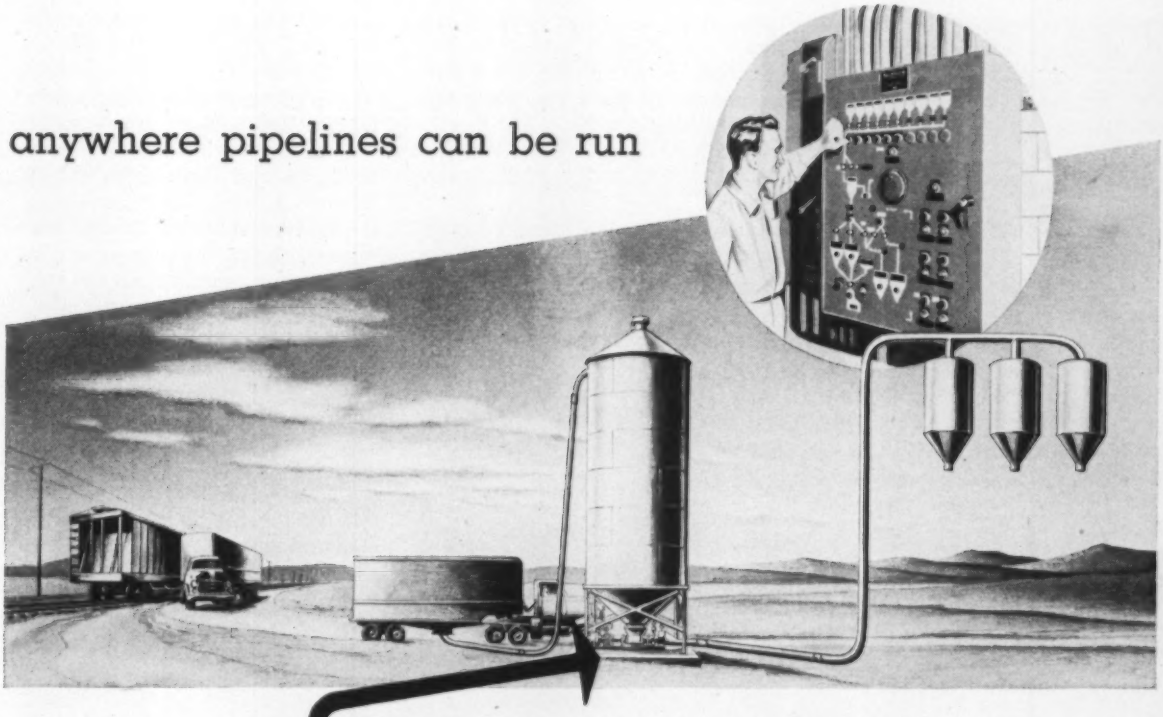
Gluer and Folder

Item 412—Addition of a folding device and pressure section to a standard topside margin gluer makes possible the gluing and folding of rigid materials. In operation, as the material is delivered topside up on the conveyor, the unglued side is held in position with a guide. A folding guide folds over the glued portion and is caught in the folded state by a flange and carried along the conveyor belt, held under light pressure to give the glue a chance to set. By the time the glued cards reach the end of the conveyor they are securely bound, ready for further processing.

The conveyor has its own variable speed motor drive to permit removing the cards from the

*For Inquiry Card, see page 17

anywhere pipelines can be run



Fuller-Kinyon Systems Convey Dry Pulverized Materials

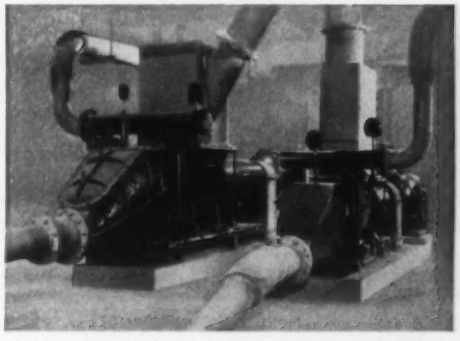
Conveying dry pulverized materials from storage to process points is but one of many applications of Fuller-Kinyon Systems, which are equally noted for transporting material from pulverizing mills and other processing equipment to storage silos; for loading and unloading cars, ships and barges, and for blending raw materials.

HOW IT WORKS

The Fuller-Kinyon System conveys dry pulverized materials through pipe lines by air. The material is fed by gravity to a short screw type impeller in the pump, which advances it to a mixing chamber wherein it is fluidized by low-pressure air introduced through a series of jets. In this fluid state the material enters the transport line, where it is advanced as a dense column by the continuing pressure of the screw and expanding air. Conveying, horizontally or vertically, over long distances, and to many points of discharge, can be easily accomplished far beyond the practical limits of mechanical conveyors.

PAY THEIR OWN WAY

The unique plant economies offered by Fuller-Kinyon Systems repay investment cost rapidly. Immediate savings are realized through bulk purchasing, and the completely enclosed systems prevent loss through contamination and spillage. Systems are easily applied to existing plants, without interfering with structures or equipment and without interrupting production. Systems operate with very little attention and supervision. Normal applications involve



only the pressing of a control button for air supply and the pump motor. Many systems are operated by automatic remote control for starting, stopping, and diversion of material flow.

SAFETY FIRST — NO RISK

The system is especially recommended to handle combustibles, such as pulverized coal and starch. The quantity of air required for aeration of the material is less than one percent of that necessary to support combustion.

IF YOU USE DRY PULVERIZED MATERIALS

. . . investigate the countless application possibilities of Fuller-Kinyon Systems—write today for Bulletin **FK-26A.**

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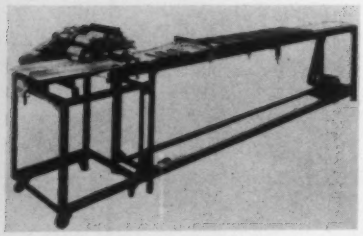
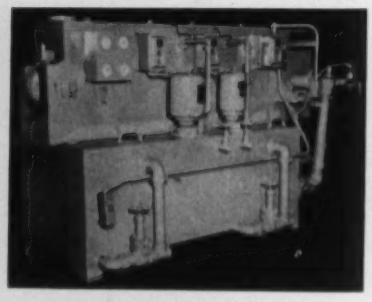


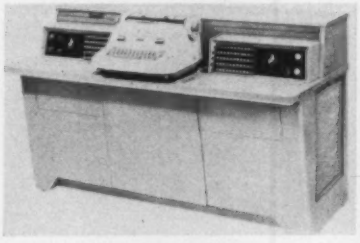
machine at a slightly faster rate than they come through the machine. This prevents jamming up of the cards on the folding device. Complete automation can be accomplished by adding automatic feeding. Cold glue is the usual adhesive for the operation, but if other materials are used which require hot glues, the machine can be supplied with a thermostatically controlled glue heater. The illustrated application shows die-cut sheets of cardboard being fed through the machine. Adhesive is applied to the portion of the card having the die cuts. **Potdevin Machine Co.**, 200 North St., Teterboro, N. J.—*Circle 412.



Parts Washer

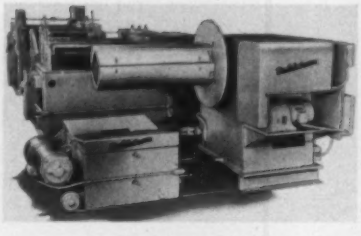
Item 419—Chips, filings, oil and grease are removed from work parts which are conveyor delivered to the washing machine from screw machines. The washing machine employs a metal mesh conveyor to carry the work parts through sprays of heated detergent solution followed by a hot rinsing spray. The cleaned parts are then discharged from the delivery end of the machine ready for the next operation.

The machine measures 3 by 4 by 6 ft and processes parts up to 3 by 6 inches. Designated Model CT 6 x 3 WR, it is heated by gas but may be adapted for steam or electricity. The unit may also be connected to turret lathes and other machining operations by multiple collecting floor conveyors. **Industrial Systems Co.**, Matawan, N. J.—*Circle 419.



Typewriter Selector

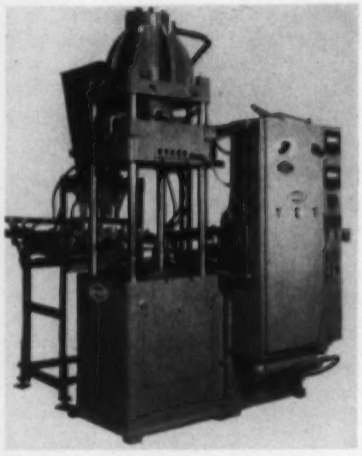
Item 442—Designed to handle a large volume of personalized repetitive correspondence, dual selector machine is called the Autotypist Model No. 5660. The unit may be used with any standard electric typewriter, operating at speeds up to 150 words a minute, without error, and accommodates two record rolls, with a total capacity of 500 typewritten lines in the form of individual paragraphs or separate complete letters. The pushbutton selector carries 100 or more different paragraphs, from which any combination of paragraphs can be automatically selected and typed. Model 5660 features automatic stops for the manual fill-in of personalized data. Using the desk unit, an average typist can produce as many as 125 letters a day. **American Automatic Typewriter Co.**, 2323 N. Pulaski Rd., Chicago 39, Ill.—*Circle 442.



Decoiler and Press Feed

Item 435—Comprising a coil lift, coil reel, edge trimmer, scrap chopper, press feed unit and control panel, decoiling and press feed line is used by an air conditioner manufacturer. The equipment takes a coil of material, gives it commercial flatness, measures it to proper lengths and feeds it into a press.

The surface measuring operation utilizes a Berkeley-Dahlstrom measuring controller. Measuring is accomplished by mechanical means and this information is converted from mechanical to electrical units and fed into the measuring controller where any desired length may be selected. The controller is of the dual preset type whereby a slowdown of the press feed unit is initiated at the first preset number. At the second preset number, which is the desired length, the full braking action is accomplished. At this instant, the press is signaled to cycle. As the ram of the press is about to reach the top of its stroke, it resets the measuring controller and starts the press feed unit automatically on another cycle of operation. **Dahlstrom Machine Works Inc.**, 4227 W. Belmont Ave., Chicago 41, Ill.—*Circle 435.

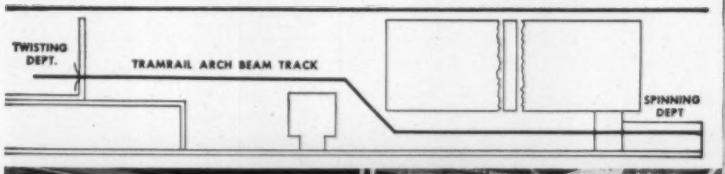


Combination Press

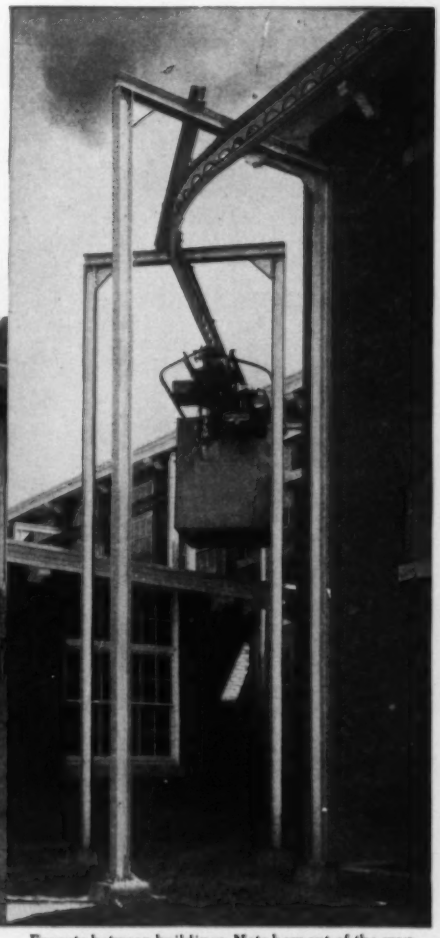
Item 439—Automatic compression or transfer molding are possible on one press with hydraulic transfer cylinder which has been added to the fully automatic press. The turn of a knob makes it possible to switch to either automatic compression or transfer molding. The combination unit thus performs automatic compression mold-

*For Inquiry Card, see page 17

$15,000 AUTOMATIC DISPATCH SYSTEM



The carrier operates only after the van doors are closed firmly. Then pushing a button starts it on its way. Building doors are opened and closed automatically. When the carrier reaches its destination, it simply stops and remains in place until loaded or unloaded. Depressing a button returns it to the other building.



Enroute between buildings. Note how out-of-the-way space that ordinarily is unusable for any purpose serves as a satisfactory right-of-way for an automatic Tramrail system.

PAYS FOR ITSELF IN FIFTEEN MONTHS

Big savings almost invariably follow the installation of a Cleveland Tramrail automatic dispatch system. This holds true for the installation at Erlanger Mills, Inc., Lexington, N. C. Because of time saved, the entire cost of the equipment was paid for in less than fifteen months. But this was not the only saving. Savings in a year from elimination of truck wear on the floors are estimated to amount to as much as the cost of the system.

The system handles boxes of bobbins from the spinning department on the first floor of one building to the twisting department on the second floor of another building. The vast amount of tedious manual trucking formerly required has been eliminated. Regardless of weather condition, season of year, or time of day or night, the automatic system hauls its loads unhampered. No men are needed especially for this work since men in both buildings can take care of the simple task of loading and unloading the Tramrail van along with their regular work.

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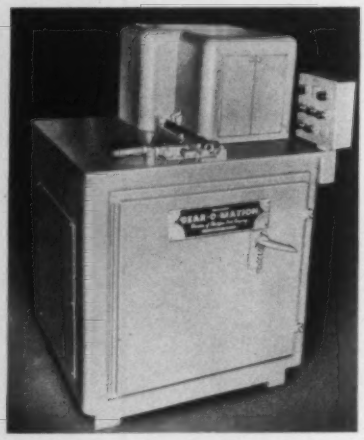
CLEVELAND TRAMRAIL
OVERHEAD MATERIALS HANDLING EQUIPMENT

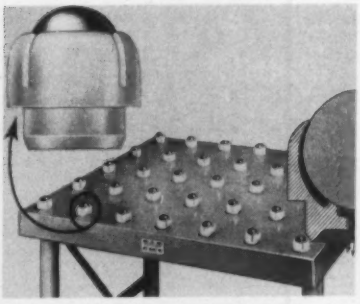
ing functions as well as quick changeover to a transfer operation. Reduced costs are the result of the press unit, since it is not necessary to purchase a transfer press and a compression press, with each idle part time. **Plastic Press Div., Baker Bros. Inc.,** Toledo 10, O.—*Circle 439.



Automatic Skew Loading

Item 421—Designed for high volume gear heat treating operations, automatic skew loader is applicable to other center-bored parts and production methods. In operation, the gears enter the skew loader through a gravity expandable track and are stopped by an escapement mechanism. From the escapement, gears are fed one at a time into a V-track and are pushed forward by the plunger of an air cylinder actuated by a proximity switch. The air cylinder, returning to neutral, triggers a limit switch controlled solenoid which releases another gear. An average skew load of about 14 gears is readied in less than 5 seconds.

When a full load is positioned, the operator inserts a skew or rod through the center bored holes and lifts the load onto a gear carrier. The unit not only loads much-alike gears but can be converted to bigger or smaller gears simply by changing the retaining fixtures. Pushbutton controlled, the unit can be run manually as well as automatically. **Gear-O-Mation Div., Michigan Tool Co.,** 7171 E. McNichols Rd., Detroit 12, Mich.—*Circle 421.



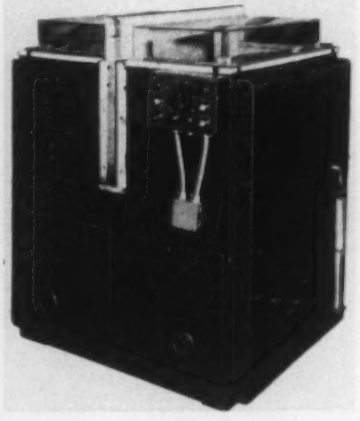
Ball Transfers

Item 410—For use in food manufacture and processing equipment, ball transfer unit is impervious to food acids, steam cleaning, salt brine, detergents, mild acids, alkalis, oil, sand, grit and all weather conditions. The unit differs from conventional designs by having the bottom of the retaining cup entirely open to permit continuous self-clearing and to prevent clogging. The cup is made of Metzgar-Nylo, designed to support the ball on friction reducing protrusions that require no lubrication. The cup is slotted to permit the ball to be snapped out for total cleaning. **Metzgar Conveyor Co.,** 412 Douglas St. N. W., Grand Rapids, Mich.—*Circle 410.

Round Steel Strapper

Item 423—Useful in the packaging of newspaper and magazines as well as bundling asphalt roofing, automatic round steel strapping machine is designed to meet the packaging and bundling requirements created through automation and the demand for greater production. The Model-12 machine can tie packages from 2 inches high by 8 inches wide to 20 inches high by 26 inches wide. The standard machine is capable of tying packages up to 16 inches high and 22 inches wide. All functions are mechanically controlled and interlocked, enabling a capacity of 24 ties per minute.

The machine uses from 14 to 18 gage round steel strapping. A built-in lubrication system takes care of all working parts by pulling a lever. Tension can be predetermined by means of a simple spring adjustment. **Gerrard Steel Strapping Div., U. S. Steel Corp.,** 2915 W. 47th St., Chicago, Ill.—*Circle 423.



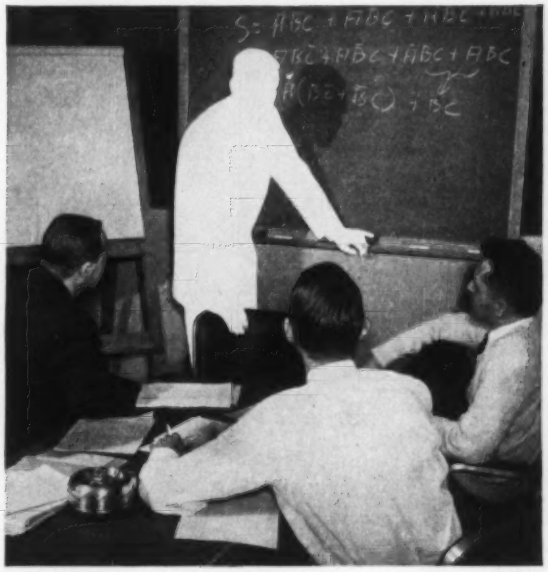
Spray Etching Machine

Item 430—Capable of etching both sides of a copper-clad board up to 20 by 24 inches simultaneously, or one side only, spray etcher can be used for etching very small parts or in the printed circuit field. The machine consists of two banks of nozzles, each bank fed by a separate variable speed pump and so arranged as to etch both sides of a circuit board simultaneously.

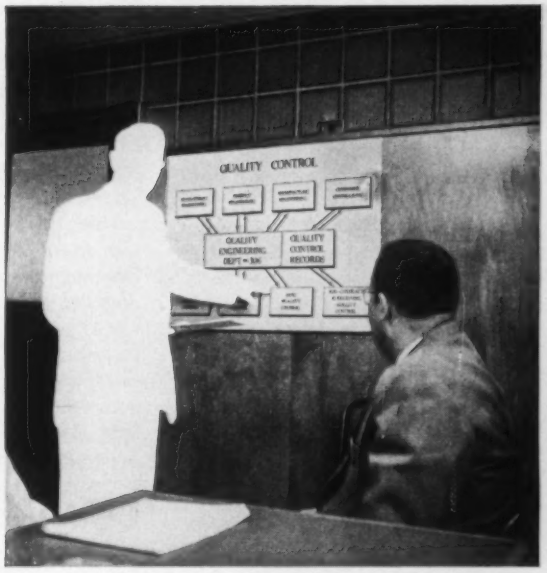
The circuit board enters the machine in a vertical position in a holder which slides in and out of the machine. The pumps are fed from a supply tank which has thermostatically controlled heaters

*For Inquiry Card, see page 17

IBM GROWTH promoted these men



Computer Logical Design Engineer: Before his recent promotion, this man was responsible for determining the broad systems outline of an electronic computer and its interconnection with external equipment. "In this job," he says, "you tailor such characteristics as computer speed, memory, size and arithmetic structure to the requirements of the computer system." He maintained close liaison with mathematical support, circuit designers, packaging and test engineers.



Quality Control Engineer: Also promoted recently, this man worked in Manufacturing Engineering. He was responsible for the performance of IBM electronic computers and other business machines. "The problems of Quality Control in this company are endless—and fascinating," he says. "You may be concerned with transistors and cores . . . gaseous electronics . . . diffraction of alloys . . . reliability studies. *There's always something new*—in this new and progressive field!"

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- Test equipment design

The electronic computer field offers one of the best ground-floor opportunities today. Economic experts rank it with automation and nucleonics in growth potential. Sales at IBM, the recognized leader in this fast-growing field, have doubled, on the average, every five years since 1930. Engineering laboratory personnel has quintupled in the past five years. IBM's excellent salaries and employee-benefit programs are instrumental in achieving an employee turnover rate far below the national average.

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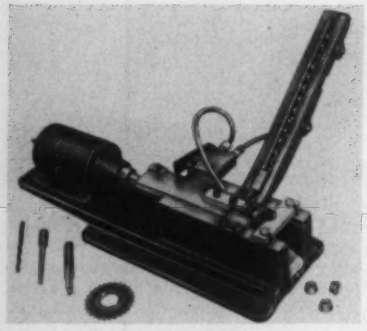
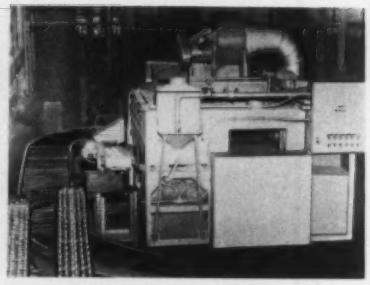
to maintain a uniform temperature of the solution and has a drain valve and connection to drain the machine directly into the customer's sewage system. The machine is equipped with a gage to show the depth of the solution in the supply tanks, as well as a hydrometer to indicate the Baume scale of specific gravity of the solution. A valve and connection are provided to permit the addition of water directly into the supply tank. A timer is provided with switches to provide either timed or continuous spray operation. **Robertson Photo-Mechanix Inc.**, Dept. LF, 7440 Lawrence Ave., Chicago 31, Ill.—*Circle 430.



Work Feeder

Item 424—Originally developed to deliver, hold and eject small workpieces automatically to a working machine, feeder which is powered by compressed air features new design. Several improvements have been effected with the redesign of the Model 43 reciprocating work feeder. The air cylinder has been changed to take a larger diameter return spring for longer spring life and more uniform tension, and the spring is recessed in the cylinder cover to save space.

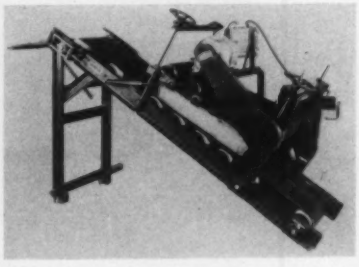
The oilite bearing surface has been increased to provide more accurate alignment of the ram, smoother travel and less friction. The slide and dovetailed ways are more exactly uniform in dimensions, to facilitate replacements when parallel, ready to be assembled into combination with other units with a minimum of makeready. **Mead Specialties Co.**, Dept. WF-46, 4114 N. Knox Ave., Chicago 41, Ill.—*Circle 424.



Multiprocess Cleaning

Item 431—Combination continuous drum and belt conveyor type cleaning machine washes, rinses and dries small work or parts in the drum section, while larger work or tote pans are processed in the conveyor section. The drum and conveyor type units are contained side by side in the same machine housing and integrated so that the same pumps, tanks, blower and heating equipment serve both sides.

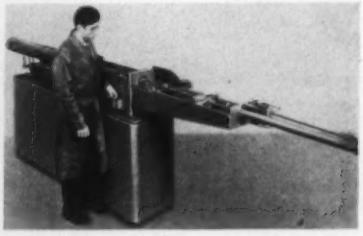
Completely automatic operation can be provided by integrated loading, unloading and transfer equipment, as required. One-man operation is provided by return conveyors. Small work or parts processed in the drum section are automatically returned by belt conveyor to the charging end; larger work or tote pans processed in the conveyor section are automatically discharged onto a gravity type conveyor returning to the charging end of the machine. Design of the cleaning unit permits incorporation of pickling, neutralizing, phosphate coating or similar processes. **Ransohoff Inc.**, N. Fifth St. at Ford Blvd., Hamilton, O.—*Circle 431.



Bag Flattener

Item 407—For continuous operation in production lines, heavy duty belt type bag flattener produces neat, well-formed bags. Handwheel adjustment for both receiving and discharge end of the hugger conveyor is provided. The discharge end can be fitted with an adjustable steel apron or a bar type glue chute with glue pan. Glue applicator wheels can be provided to allow bags to be glue stripped for palletizing. A thermostatically controlled electric heating element can be mounted in the glue pot to keep glue at the desired temperature.

The standard unit is 24 inches wide with 6-ft 8-inch centers and powered by a 1½ hp gear motor. It can be furnished horizontal for floor mounting, with casters for portability, or can be inclined up to 35 degrees. **Flexoveyor Mfg. Co.**, 1220 S. Acoma St., Denver 23, Colo.—*Circle 407.



Broaching Fixture

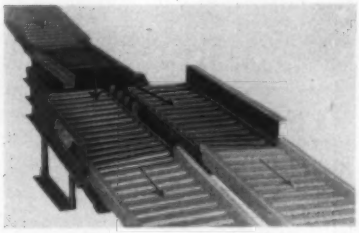
Item 418—Automatic broach handling and part ejection devices are included in self-contained, air-powered broaching fixture. In addition to the tandem air-hydraulic cylinder that pulls the broach through the part, the fixture has a second air cylinder which operates a broach retriever mechanism. A third air cylinder operates a part ejection device.

Operator safety and production efficiency are achieved by the semi-automatic loading features of the fixture. A part is loaded on the locating platform, and a cycle valve is operated. Then the part is broached in a fully automatic cycle, with the part automatically ejected after broaching.

The illustrated unit broaches a round hole in each of two ⅜-inch diameter, 1-inch long bushings that are pressed in a die-cast electric windshield wiper bracket. The in-

*For Inquiry Card, see page 17

line bushings are approximately 4 inches apart. The holes are broached to a 0.001-inch diameter tolerance and must be in line within 0.0005-inch. A combination broach-burnisher tool is used in an 8-second machining cycle. **National Broach & Machine Co.**, 5600 St. Jean Ave., Detroit 13, Mich. —*Circle 418.



Package Separator

Item 408—For automatic operation, gravity and power Auto-Diverger offers controlled package separation. Items can be separated to specific lines by type of mounting, machine demand, size differences, weight differences or by color code identification. Cases can be fed at a conveyor speed of 150 fpm. The cases can be end to end on the conveyor line and the device separates them as required without stopping the flow. In the illustration, the arrows indicate directions of packages from one line to two lines. **Standard Conveyor Co.**, N. St. Paul 9, Minn. —*Circle 408.

Hardness Tester

Item 416—Up to 1000 parts are handled per hour by automatic go—no go Brinell hardness tester. The unit was developed for production line testing of odd-shaped automotive forgings weighing 10 pounds apiece.

Constructed as a revolving three-station tester, the machine automatically grinds a smooth test surface, applies load, measures depth of impression, and accepts or rejects Brinelled parts without manipulation by the operator. In using the hardness tester, the operator places two parts at a time

*For Inquiry Card, see page 17

AUTOMATIC CONTROL NEWS

by Dynamics Research Associates

dynateq
a new approach to solving automatic control problems

In response to a growing demand among automated industries, Dynamics Research Associates introduces ***dynateq***—a completely integrated method which assumes responsibility for every phase of automatic control, from the initial research to the construction and installation of the necessary controllers.

DRA engineers first make a complete analysis of your problem, using the latest techniques of modern servo technology. DRA then designs a practical, dependable ***dynateq*** system of inherent high performance which best meets your individual requirements.

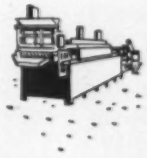
Whether the control system involves a simple layout drawing and breadboard model, or a more elaborate system requiring the use of the electronic computers, DRA engineers, physicists and applied mathematicians have the extensive experience, technical knowledge and proven competence to do the job efficiently and economically.

DRA also manufactures the ***dynamag*** line of magnetic amplifiers and other control components, including saturable reactors, transistorized inverters, transistorized frequency converters, D-C regulated power supplies and line voltage regulators.

The ***dynamag*** Operational, Differential and Servo Motor Magnetic Amplifiers are produced in a variety of sizes and specifications to meet all automatic control applications.

TYPICAL *dynateq* SYSTEMS
Designed to solve specific problems

dynateq R-3
Potato Chip Fryer Control

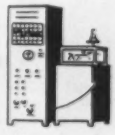


Automatically controls the speed of the input belt to maintain a constant front end fat temperature (plus or minus 5°). Holds spoilage and fat losses to a minimum.

dynateq F-18
Hydraulic Pressure Metering System.

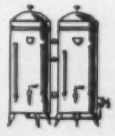
Aircraft hydraulic pressure is measured by a rugged, accurate strain gage instrument. ***dynamag*** highly stable magnetic and transistor instrumentation used.

dynateq R-8
Viscose Pulp Tester



Automatically tests viscose pulp sample for filtration plugging value, records results on graph for quick visual reference.

dynateq R-1
Thermal Overload Protector



Automatically protects coffee urns from bursting because of overheat and supplies overflow protection when used with a solenoid valve.

Put *your* automatic control problems in the hands of experts. Call on Dynamics Research Associates to design a *dynateq* control system to meet your individual needs. No obligation for proposals, of course. For further information, write

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A Division of Universal Match Corporation
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*Designers of **dynateq** Automatic Control Systems • Manufacturers of **dynamag** Control Components*

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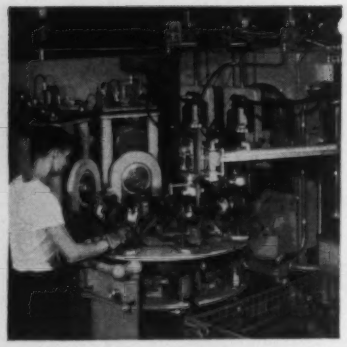
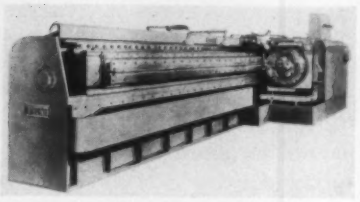


in the holders on the periphery of the large circular worktable, movement of which is controlled by a preset timer. The table automatically rotates a quarter-turn to the grinding station, where a small area is ground by twin grinding wheels.

The parts are then moved to the second station where a standard Brinell load of 3000 kg is applied on the ground surface. At the same time, the depth of the impression in each of the two parts is measured electrically. The depth of the impression is in direct relation to the relative hardness of the part and readings are transmitted to the go—no go memory units at the third station. The Brinelled parts are then picked up individually and either sent to the next operation by a conveyor belt or dropped into a reject pile, according to their hardness. **Tinius Olsen Testing Machine Co.**, 5860 Easton Rd., Willow Grove, Pa.—*Circle 416.



Big Broaching Machine

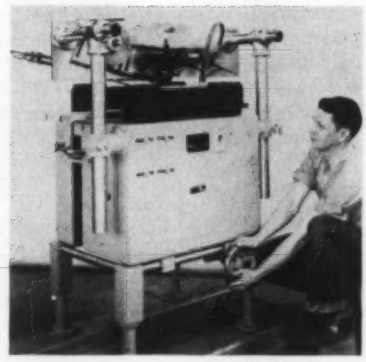
Item 427—Featuring a 240-inch stroke, electromechanical drive horizontal broaching machine is used to broach the pine tree holding slots in the periphery of the gas turbine wheels of a 16,500 kw gas turbine engine. The machine broaches a slot 1.6-inches deep and up to 5-inches in rim thickness, removing 150 lb of metal per wheel. The broaching time per wheel is $2\frac{1}{3}$ hours.

The slot is broached in two passes; length of the broach cutting section totals 450 inches. By changing broaching tools and using adapter plates on indexing fixtures, each turbine and compressor wheel can be broached on the same machine. The machine is also adaptable to other surface broaching jobs which require a large amount of stock removal, in such industries as aircraft, automotive and agricultural. The machine is designed with provisions for automatic and manual indexing. **Lapointe Machine Tool Co.**, Hudson, Mass.—*Circle 427.

Outsert Applicator

Item 414—Machine which fits into a production line is designed to attach a consumer message to the outside of a product container. Recipes, production applications, coupons, contest rules,

*For Inquiry Card, see page 17



or physician's literature can be outserted on the package.

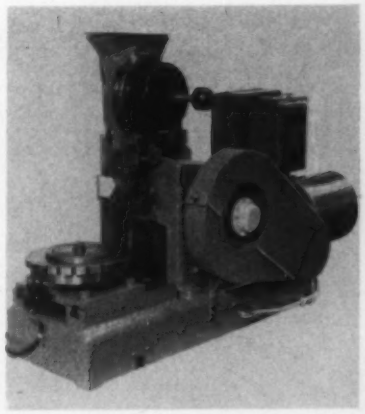
The Model OA-3MC machine accurately attaches outserts at rates up to 220 containers a minute. Any cylindrical container of glass, metal, plastic or paper with dimensions ranging from 2⅝ to 7¼ inches in length and 1¼ to 6½ inches in outside diameter can be handled by the machine.

When a free rolling container leaves the labeling machine and enters the outserting unit, it is gripped by parallel belts to stop rotational motion. Preset adjustments face up only that point on the container which is to be taped with the outsert. The container then moves to the outserting mechanism where a fast-acting feeder lays the outfold in place and the tape dispenser feeds the right length of tape to affix the outsert firmly to the container. The outserted container then goes on to the casing machine and is readied for shipment. **Pfaudler Co.**, 1026 West Ave., Rochester, N. Y.—*Circle 414.

Automatic Riveter

Item 420—Developed to rivet ball bearing retainer rings, automatic dial-fixture machine, Model RT-52, is applicable to other riveting operations. The dial fixture is fully automatic. When the cycle is actuated, the machine table indexes a full 360 degrees through from six to 36 stations, and automatically stops when completing the riveting operations. The entire fixture can be positioned to handle retainers from 2 to 6½ inch pitch diameter, and the stations can be adjusted.

The machine is also equipped



with quick change raceways and is driven by a ⅓-hp electric motor. Since the flywheel speed is only 78 rpm, obtainable by reductions through a gear head motor and V-belt drive, the machine is capable of handling only small rivets up to 1/16-inch in diameter, or tubular steel rivets up to 3/32-inch in diameter. A spring-loaded connecting rod automatically compensates for variations in material thickness. **Milford Rivet & Machine Co.**, Milford, Conn.—*Circle 420.

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FOR CUSTOMIZED CONVEYORS WITH MAY-FRAN STANDARDIZATION

Developed to provide the ultimate of versatility, the May-Fran program of STANDARDIZATION permits users to create and construct their own conveyors to meet individual needs.

It literally provides a type of "super market" shopping for the straight, curved, inclined, take-up and discharge end sections required to meet the specifications of YOUR job requirements. Sections can be furnished to meet belt width as well as load bearing and volume capacities. Conveyors can be changed relative to length or width with only a minimum of downtime.

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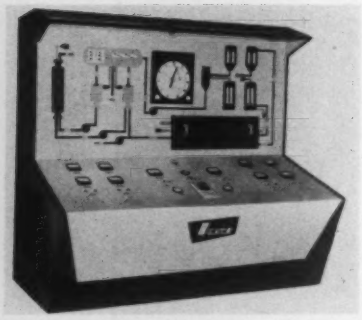
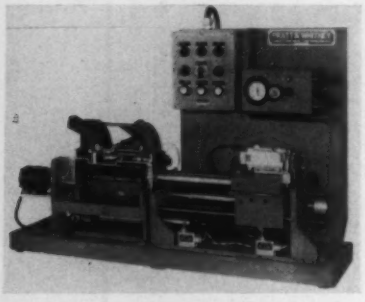


Control System

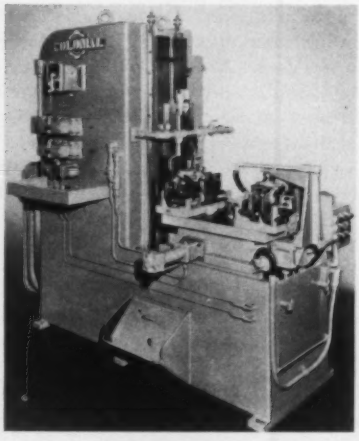
Item 434—Designed for the specific control of a process or machine, completely assembled panelboard or console systems are available for explosion-proof installation as well as for dust-tight, air-purged or drip-proof use. Typical applications of the systems include: Liquid batch mixing controls; continuous or batch operation furnace, oven and dryer panelboards; controls for plastics or packaging machinery and machine tools; ammonia dissociator systems; automatic operation of autoclaves and feed control stations; sequencing, transfer, indexing, alarm and annunciator systems. Illustrated system is designed for demineralization control. **Devco Engineering Inc.**, Dept. A, P.O. Box 387, Caldwell, N.J.—*Circle 434.



Tube Gaging Machine

Item 432—Capable of rapid automatic gaging of all types of applications where wall thickness, end thickness and diameter of tubing are to be gaged, automatic machine checks the wall and bottom thickness of tubing and separates it into good, rectifiable and rejected categories at the rate of 1000 units per hour. Known as the Automatic Tube Thickness Gaging Machine, the unit was originally designed for use with aluminum tubing.

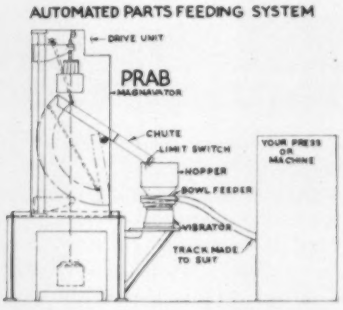
In operation, aluminum tubes are fed into a chute from which they are transferred to a nest of rubber rolls rotating at approximately 600 rpm. As the tubes rotate, gaging contacts enter the open ends, exploring the wall thickness on the helix that is generated. At the end of the stroke, bottom thickness is measured. After the gaging slides are retracted at faster-than-gaging speed, the contacts operate two Sigmatic Microlimit gage heads which sort the tubes into classification conveyors which discharge them into bins of the proper category. **Pratt & Whitney Inc.**, W. Hartford 1, Conn.—*Circle 432.



Surface Broaching Unit

Item 411—Index table is an addition to Ram Press machine for surface broaching. The table uses a 180-degree index, and is manually fed and automatically unloaded. Features of the table include: Self-locking of the fixture by the indexing action, precision alignment, and high performance with safety.

Set up for a manufacturer of automotive hardware, the machine with a built-in index broaches 1200 rocker arm assemblies an hour. The parts are loaded two at a time, automatically clamped, double broached in one pass, and automatically ejected. Cycle time at 100 per cent efficiency is 6 seconds. The machine is the 4-ton capacity, 24-inch stroke model. Other models in the line are rated at 6 and 10 tons. Automatic loading and transfer type installations are available. **Colonial Broach & Machine Co.**, P.O. Box 37, Harper Station, Detroit 13, Mich.—*Circle 411.



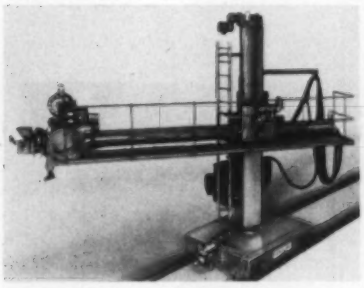
Small Parts Feeding

Item 433—Designed to eliminate the human element in the loading of automatic presses and assembly machines, small parts feeding system transfers, meters and feeds small parts such as pins, nuts, rivets, etc., from skids or receiving containers to their desired locations for further manufacturing operations. The automated feeding system incorporates the Magnavator, an automatic small parts elevator, which is used in conjunction with a bowl feeder. The parts elevator performs the first automatic operation in the sequence.

Small ferrous parts are picked up by a housing containing one or more Alnico permanent magnets and lifted by a chain drive mechanism. At a predetermined level, an air gap is formed by the magnets moving away from the nonmagnetic housing, and the small parts fall to a receiving tray which is hinged and whose position is governed by the location of the lifting mechanism. The receiving tray, when in position, joins the discharge spout and the parts slide down, through a demagnetizer, to the mouth where a limit switch controls the material level of the container being fed. At this point the next automatic operation begins. The bowl feeder, agitated by a vibrator, draws from the Mag-

*For Inquiry Card, see page 17

navator fed hopper and automatically feeds, aligns and meters parts in the proper amounts to the desired press or machine, completing the automated operation. **Prab Conveyors Inc.**, 30121 Groesbeck Highway, Roseville, Mich.—*Circle 433.



Manipulator Unit

Item 415—Featuring a removable catwalk in place of the operator's pulpit, welding head manipulator is designated Model 12 x 12 RBM. The manipulator has an arc height of 12 ft, 0 inches, horizontal arc travel of 12 ft, 0 inches and is mounted on a self-propelled travel car with 360-degree manual rotation of the column; power rotation is also available. The catwalk allows inspection personnel access to weld operations during actual welding on large diameter tanks.

Welding power source and flux recovery system are mounted on a bracket attached to the column, permitting 360-degree rotation without snarling electrical cables or flux hose. All manipulator controls, welding controls and turning roll or positioner controls, including a tachometer for remote speed indication, are mounted at the end of the boom. **Pandjiris Weldment Co.**, 5151 Northrup Ave., St. Louis 10, Mo.—*Circle 415.

Belt Conveyor Furnace

Item 422—Designed for use with a controlled atmosphere, mesh belt conveyor furnace is applicable for firing steatite, ferrite and titanate parts, ceramic coatings and capacitors as well as for the sintering

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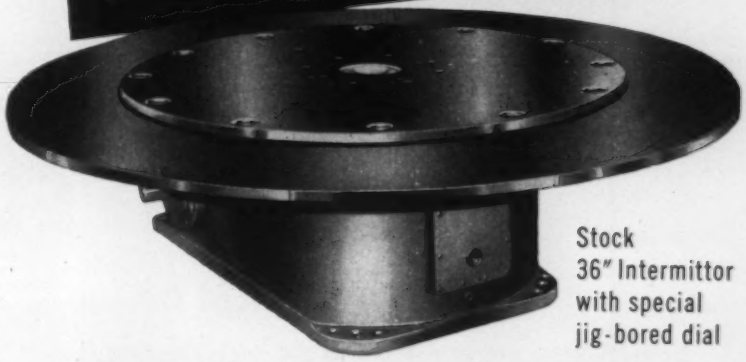
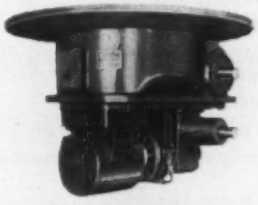
STANDARDIZED AUTOMATION!



Stock 36" Intermittor with special jig-bored dial

50% - 100% Increase in Production with FERGUSON HIGH SPEED INDEX TABLES

Up to 30,000 Pieces per Hour



Standard Table and Power Section

Stand and Auxiliary Tool Mounting Plates

The standard Ferguson Intermittor is a *must* for operations such as machining, joining, forming, staking, piercing, assembling, testing and inspection that require a combination of high speeds, long dwell or work time, and smooth indexing.

There is a standard Intermittor for almost every application, offering a choice of stops, dial size, degree of movement; and a table for either extreme precision or high torque usage. Seldom do you have so much selection in a line of standard production machinery . . . with all of the benefits of standardization PLUS many of the advantages of custom designs! The Intermittor operates at speeds far greater than those possible with other types of index tables. The special acceleration characteristics of the FERGUSON ROLLER GEAR DRIVE insure smooth starting and stopping with little shock and vibration, at speeds up to 500 indexes per minute.

Over 150 standard models . . . many in stock! Get complete information on load ratings and dimensions . . . write for your file copy of Catalog No. 301.

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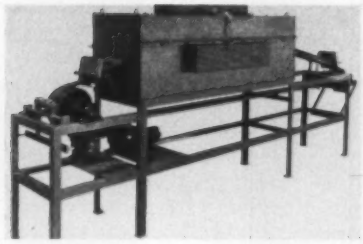
Technical Editor

Automation has an opening for an engineer with manufacturing-production-equipment background and ability to write. Age 25-30.

Headquarters are in Cleveland, but there will be opportunity to travel on editorial assignments and attend meetings, expositions, etc.

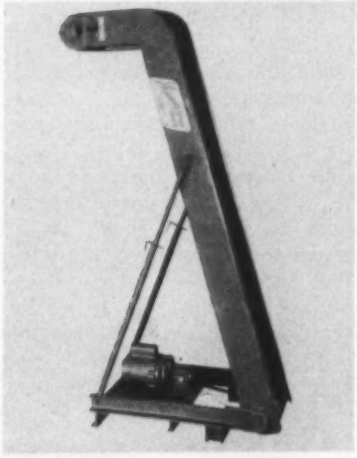
This is a real challenge for a man with enthusiasm for writing and a strong creative urge to broaden his perspective and assist industry in effectively applying the techniques of automation.

Please send particulars to the Editor, AUTOMATION, Penton Building, Cleveland 13, Ohio.



of powdered metals and heat treating of metal parts. The belt runs through an alloy muffle that is horizontal where it passes through the furnace chamber, and sloped downward on either end. The muffle traps both the protective atmosphere and the heat. Curtain burners on both ends of the muffle help to prevent the entrance of contaminating gases.

Zoned heating provides required temperatures in the furnace chamber. The time that the work is in the furnace can be controlled by a variable speed drive. Preheat and cooling chambers prevent thermal shock. The mesh belt permits volume production along with versatility by conveying parts of varying sizes and shapes. **Hevi-Duty Electric Co.**, Milwaukee 1, Wis.—*Circle 422.



Magnetic Conveyor

Item 425—Developed to solve tote box loading problems in operations where it is necessary to locate the tote box as close as possible to the base of the conveyor, magnetic conveyor features a specially designed delivery extension

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STOCK GEARS
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OHIO
SPECIAL GEARS
"TO YOUR SPECIFICATIONS"

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• Ohio Stock Gears offer substantial savings in many ways — no wasting time — no delivery delays — replacement is quicker when you standardize with stock gears.

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Special-Purpose
TELEPHONE HANDSET

You can mount this special-purpose hang-up telephone almost anywhere: on desk, wall or piece of equipment. The handset shown is only one of many standard and special-application types you may order. The right-angle bracket provides 6 different mounting positions.

HOOKSWITCH

You can get hookswitches with any spring combination you need. Illustrated are two of many possible arrangements.

BRACKET

This special bracket gives you a choice of 12 different mounting positions. You may order it separately or with any combination of components you need. You'll find complete details in Booklet T-5005. To get your free copy, write to

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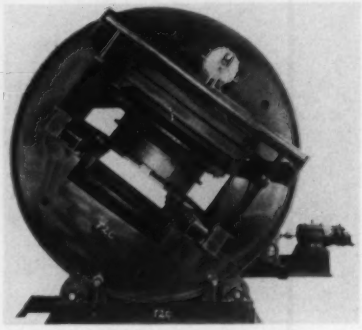
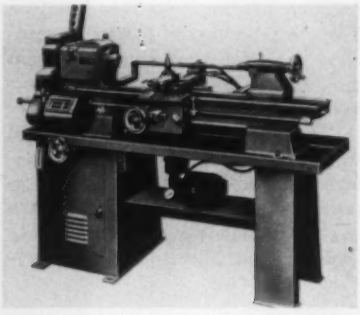
which extends beyond the base of the conveyor. The conveyor incorporates an adjustable feature permitting the setting of the angle of incline so that the receiving end of the conveyor fits under the discharge chute of all standard presses. When the angle of incline is reduced, conveyor reach is extended so that the extension section may be centered over a tote box. In this way, material is discharged into the approximate center of the tote box, eliminating the need for chutes. Even when the conveyor is operating at its lowest incline, standard tote boxes clear the delivery extension without moving the conveyor. The design of the extended section makes it possible to maintain full magnetic control of the material being conveyed to the discharge point. **Homer Mfg. Co. Inc.,** Dept. 286, Lima, O.—*Circle 425.



Rotating Tilter

Item 429—Cleaning of molds is facilitated with rotating tilter which handles copes weighing up to 3500 lb. The tilter consists of a carrying bed formed by two parallel lanes of chain driven live roller conveyor and an air operated hold-down section framed in circular tracks running on double-flanged wheels. The unit is rotated by means of a wrapped chain drive, spring cushioned on both ends, powered through a motor and reducer with pushbutton controls.

Incoming cope is received from the connecting conveyor. Signal rolls automatically center the cope on chain driven roller bed and activate the air operated hold-down section. The operator then rotates the unit, through pushbutton controls, to the desired position for cleaning the top side of cope. He may then rotate the unit in the opposite direction to a position for cleaning the other side. Both cleaning operations are accomplished from the same side of the tilter. When cleaning is completed, the unit is rotated back to its original position, the hold-down section is released, and the cope is advanced on through the tilter and discharged onto a connecting conveyor. The illustration shows the unit partially rotated to cleaning position with a cope locked in place by the hold-down section. **Logan Co.,** Louisville 6, Ky.—*Circle 429.

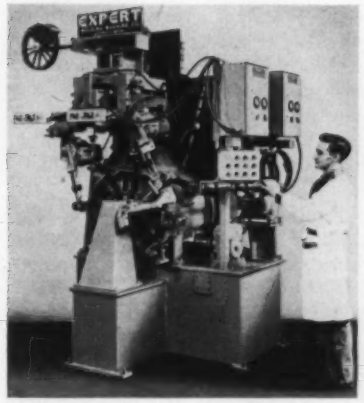


Tracer Lathe

Item 402—Reproduction of multiple diameters, tapers, bevels, shoulders, radii, grooves and chamfers is provided by 12-inch tracer lathe. Power to feed and hold the cutting tool is provided by a hydraulic cylinder housed in a servomotor mounted on the lathe cross slide. Motor, pump, reservoir and pressure gage are an integral unit and are located on the shelf under the lathe chip pan. Template mounting bar is designed for templates made of $\frac{1}{8}$ to $\frac{1}{4}$-inch flat stock.

The drive is variable speed, making available any spindle speed from 43 to 222 and 250 to 1300 rpm without stopping the lathe or shifting belts. The tracer handles work up to $2\frac{1}{2}$ inches diameter differential and 18 inches in length. **Clausing Div., Atlas Press Co.,** 2100 N. Pitcher St., Kalamazoo, Mich. —*Circle 402.

*For Inquiry Card, see page 17



Index Welder

Item 403 — Eight-station trunnion type index arc welding machine features a cam index mechanism and a simple cam clamping mechanism. Use of these mechanical systems decreases cycle time, thereby increasing production. Illustrated machine welds, by the CO_2 shielded arc method, an outer cup and support bracket together to produce 433 automotive motor mount bracket assemblies per hour at 80 per cent efficiency. By changing the clamping fixture, the machine can be adapted to a variety of two-piece parts which require joining with longitudinal welds. The basic design is adaptable to submerged arc or argon shielded arc welding.

The machine consists of a trunnion type index mechanism driven by the standard Expert cam index drive which is enclosed in the base of the machine, eight workpiece clamping fixtures that are mounted on the trunnion and rotate about a stationary cam which automatically clamps the two pieces together during the welding and index operation, and two welding heads that are mounted on a common saddle type carriage which moves in a longitudinal direction during the welding operations. The carriage is driven by a ¾-hp electric motor, gear reducer, rack and pinion. Welding wire is fed to the two heads by means of two electric powered roll feeders which are mounted on the movable carriage. **Expert Welding Machine Co.**, 17144 Mt. Elliott Ave., Detroit 12, Mich. —*Circle 403.

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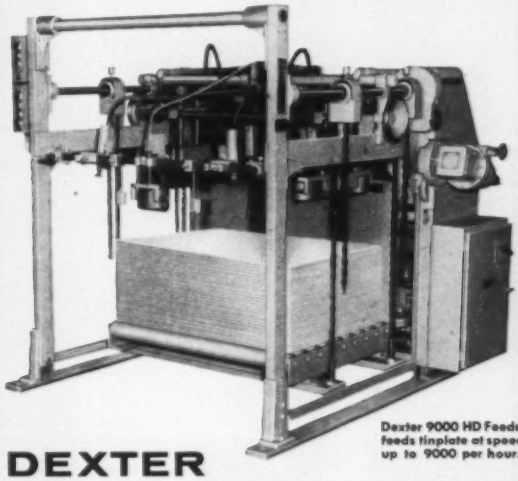
Automatic Feeding

FOR SHEET METAL PROCESSING



Dexter 9000 HD Feeder, feeds tinplate at speeds up to 9000 per hour.

DEXTER

automatic **METAL** *sheet feeders*

Dexter Feeders are available in over a hundred different sizes, speeds and load capacities to suit individual requirements. Look at the wide range of the Dexter Line . . . sheet sizes from 14x14" to four by twelve feet . . . sheet thicknesses from .006 to .200 . . . load capacities from 6000 to 30,000 pounds . . . and speeds from 600 to 9000 sheets per hour! Certainly there's a model that will fit your operation, and without doubt, step up your production.

Dexter Automatic Feeders can be attached to many types of equipment . . . Metal Decorators, Coating Machines, Shears, Slitters, Punch Presses, and numerous others.

If sheet feeding is one of your production bottlenecks, give us the details. We'll be happy to tell you what we can (or can't) do for you.

Designers of sheet handling equipment for over 75 years

DEXTER **FOLDER COMPANY**

DIVISION OF MIEHLE-GOSS-DEXTER, INC.

219 East 44th Street, New York 17, New York

Circle 698 on Inquiry Card

NOW, hopper-fed headless set screws AUTOMATE SUB ASSEMBLY!

CUT Operational Time 80% to 90%
CUT Floor Area
CUT Floor Waste from 30% to 0
CUT Worker Fatigue

The new Setko System can be used for almost any headless set screw application in sub or final assembly. All type points and most popular styles of set screws can be hopper fed.

The illustration above shows the Syntron vibratory hopper and exclusive Setko orienting device which is the heart of this new system. This orienting device assures correct positioning of set screws as small as #2 (.086" x 1/8"). Other Setko innovations include photo-electric cell control of feed flow, air power, and micro-switch actuation of the driver.

HEXAGON AND FLUTED SOCKET SET SCREWS | SLOTTED SET SCREWS | SLABBED SET SCREWS

Two Models are available. The Vertical Feed Model adapts to drill presses, vertical tapping machines, etc. The Universal Model for horizontal feeding can be used as a separate unit, or with rotary indexing work tables.

Free Demonstration in Your Plant or Ours . . . Arrange to visit the Setko plant, or ask for the loan of the new 12 minute 16-mm color movie that gives a "demonstration" in your plant or office. Ask for a copy of Catalog 21, which describes the new Setko System, plus the complete line of Setko standard and special types of set screws.

Pat. No 2,638,945
Other Patents Pending

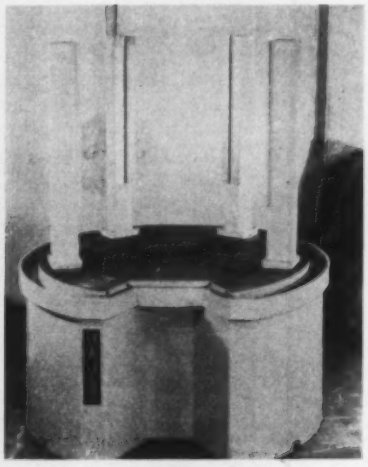
Set Screw & Mfg. Co.
266 Main Street, Bartlett, Illinois

Circle 699 on Inquiry Card

Transfer Conveyor

Item 409—To transfer all types of small stampings and metal parts from presses or other production machines, portable power conveyor uses a metal belt. Belt widths range up to 30 inches and lengths can be made to suit installation requirements.

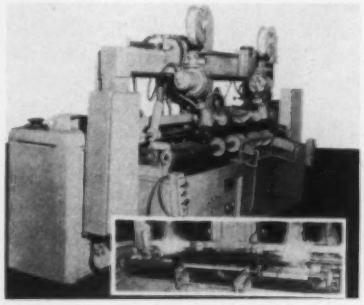
Discharge height and angle are easily adjusted; straight or bent models are available. Positive drive pulley affords continuous handling of parts, regardless of an oily condition. The motor drive, ranging in capacity from 1/3 to 1 hp, can be mounted above or below the conveyor bed. **R. T. Sheehan Co.**, 8070 Territorial Rd., Plymouth, Mich.—*Circle 409.



Radial Machine Base

Item 450—Designed to simplify the building of automation type special machines for performing drilling and tapping operations, M60C radial machine base can have any practical number of Hause Holomatic units mounted horizontally around its base center. Standard vertical columns can also be incorporated to mount the units overhead at 90 degrees. Two radial tee slots provide for easy radial location adjustment of the units. Standard clamping strips provide for lateral adjustment.

Tooling setups incorporating hand or air operated clamps, index tables, shuttle tables or trunnion fixtures can be adapted to the base. A large accessible area is provided for chip collection. The bottom of this area is tapered to a screened outlet for coolant drainage. An opening in the rear of the base is provided for internal mounting of a standard removable type coolant pump reservoir system. **Hause Engineering**, 809 S. Pleasant St., Montpelier, O.—*Circle 450.



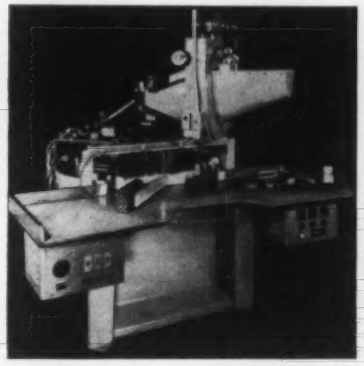
Automatic Welder

Item 453—Developed to weld truck drive tubes in the automotive industry, CO_2 welding machine is an automatic device. In operation, the universal joint assembly is welded to the drive at one end with a continuous weld bead around the diameter. At the same time the driving splined shaft is welded into the drive tube at the other end. The machine is versatile, welding drive tubes varying in length from 2 inches to 6 ft, and varying also in diameter—as required for various truck models.

The machine arc welds by the gas shielded method with bare welding wire fed automatically by a motorized feed mechanism. Direct current supplied to the heads by dual rectifier sets is used to energize the arc, which is surrounded by an envelope of CO_2 gas. The sequences are fully au-

*For Inquiry Card, see page 17

tomatic after the operator loads the assembled part into the holding fixture. The weld cycle time averages about nine seconds, depending on the diameter of the drive tubes. Rated output is 190 welded tubes per hour at 80 per cent efficiency. **Dix Engineering Co. Inc.,** 1415 Dix Rd., Lincoln Park 25, Mich.—*Circle 453.



Package Filler

Item 438—Featuring a hopper feeder for increased output, Model 628 Exact Count package filling machine handles up to 10 gross per minute, or 14 boxes containing 100 count. The machine is adapted to fill cardboard boxes with screws, nails or other headed products, by exact individual count controlled by an electronic controller which can be preset by knobs from 1 to 1000. The operator places empty boxes on a continuously rotating turntable which carries the box train to filling position, automatically releases each filled box and then returns it to the operator.

The feeder increases maximum length of screw shank to 3¾ inches; maximum shank diameter is ½-inch. Other improvements to the machine include increased maximum box length to 6 inches, and provisions for accommodating hinged cover boxes with vertical cover flaps up to 8 inches high. The machine has an automatic slowdown or trickle flow, just prior to reaching the final count, which permits exact cutoff of the flow of parts into the boxes, with zero error tolerance. **Batchelder Engineering Co. Inc.,** 125 Main St., P.O. Box 159, Springfield, Vt.—*Circle 438.

*For Inquiry Card, see page 17

he **HAD** to use a hand brace!

but **YOU** can use a Buckeye Air Tool!

Buckeye "A" Series drill, with offset handle, being used on an aluminum drilling operation. Clips hold panels in position after holes are drilled.

Why AIR Tools?

Because air is everywhere, just waiting to be put to work . . . because continuous operation can't possibly harm an air tool . . . and because, if you're using Buckeye air tools, you can almost forget about tool maintenance.

Drilling ten or a thousand holes an hour . . . in metals, woods or plastics . . . is faster, safer, easier and cheaper if you're using a modern Buckeye air drill. You'll do better work, too, because you can concentrate on accuracy, letting the Buckeye tool do the muscle work. There's a complete range of drills listed in our Catalog A-10—may we send you a copy?

In Air Tools, Your Best Buy Is Buckeye

Buckeye Tools CORPORATION

DIVISION 12 • DAYTON 1, OHIO

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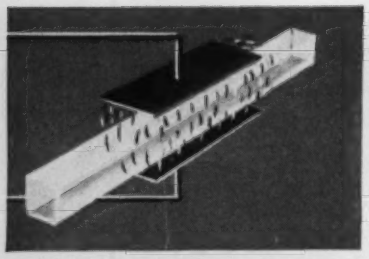

RCA POWER TUBES

FOR

High-Efficiency Electronic Heating

For long-term power delivery in dielectric- and induction-heating equipment, RCA offers industry an established group of electron power tubes for heavy-duty service. RCA tube design, associated with high-efficiency circuits, is your assurance of maximum power output—*around the clock*. Conservative ratings provide remarkably low tube cost per hour of equipment operation.

RCA Power Tubes are available in a wide choice of power ratings and frequency ranges. For prompt delivery on RCA power types, call your RCA Industrial Tube Distributor.

FREE TUBE GUIDE

24-page data booklet (PG-101-C) on RCA power tubes, rectifiers, thyratrons, ignitrons, magnetrons, vacuum-gauge tubes. Write RCA Commercial Engineering, Section F 85T, Harrison, N. J.

RCA **TUBES FOR INDUSTRY**

Radio Corporation of America
Tube Division Harrison, N. J.

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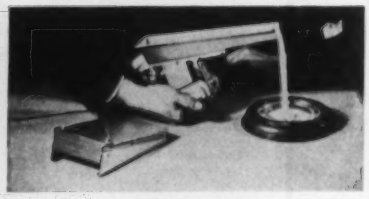
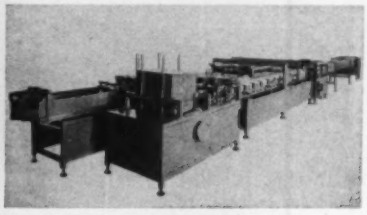


Miniature Feeder

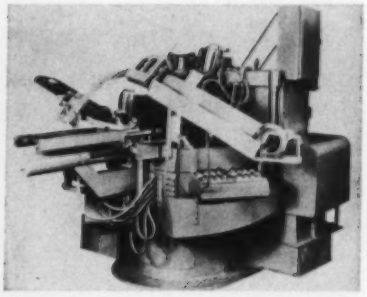
Item 444 — Used in bagging, packaging, mixing, blending, etc., portable 7-lb feeder requires no rectifier and operates directly off available ac current. Its rate of feed is completely adjustable from a maximum of 500 lb per hour to as little as a tiny trickle or a single pill or pellet at a time. It combines an electromagnet with an Alnico V permanent magnet to produce dependable, precisely controllable vibratory impulses which cause material in the tray to move forward, in a flowing motion, at a desired rate. The feeder moves some materials upward at inclines to 15 degrees. **Eriez Mfg. Co.**, 1945 Grove Dr., Erie, Pa.—*Circle 444.



High-Speed Caser

Item 446—Designed for the petroleum and chemical industries, fully automatic high-speed caser is used for gallon and 5-qt cans. The machine operates at speeds of 25 cases per minute. In one application, the machine is being used to load large cans of antifreeze and motor oil into end-loading style shipping containers. The caser is readily adapted to a wide range of can sizes, loading patterns and products.

The unit is fully automatic and requires only a part-time operator to supply the case magazine with empty, flat shipping containers. All other operations, including forming of cases, positioning them for receipt of the cans, grouping and loading into cases and sealing, are automatic. A feature of the preloading operation is the receipt of the cans, which ride upright, bead-to-bead, permitting dividing, grouping and inserting six cans per case without denting or marring. **J. L. Ferguson Co.**, Joliet, Ill.—*Circle 446.



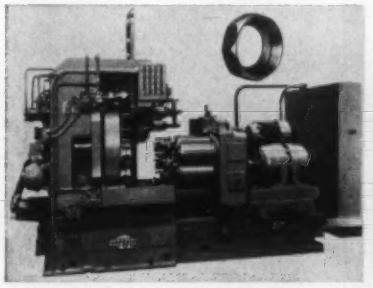
Vertical Chucking Lathe

Item 436—Available with completely automatic or semiautomatic loading and unloading, automatic size control, variable speed drive, additional tool slides and hydraulic profiling, automatic vertical production lathe is designated the Vertimax. Rigidity is provided by the elimination of cantilever or overhung type support for the tool slides. The design of the machine is based on tool slides supported at both ends, providing rigidity against cutting forces and a method of adjusting tool position by means of calibrated eccentrics. The closed circuit support for the tool slides provides rigidity for extremely heavy and interrupted cuts in a machine of compact dimensions.

Although primarily intended for repetitive production runs, the Vertimax is versatile for small quantities, since setup, changeover and tool change are quick and convenient. The tool slides can be swiveled from below horizontal to beyond the vertical position, making possible, besides normal turning and boring operations, the simultaneous machining of two internal, two external or an internal and an external taper. The tool slides are cycled automatically by hydraulic controls which employ a differential feed system. Being thus hydraulically locked, they are

*For Inquiry Card, see page 17

well suited for interrupted cutting. The differential system also senses unusual load conditions, and through the use of a pressure sensitive control, automatically returns the tool slides. **Cleveland Hobbing Machine Co.**, 1311 Chardon Rd., Cleveland 17, O.—*Circle 436.



Automatic Indexing Unit

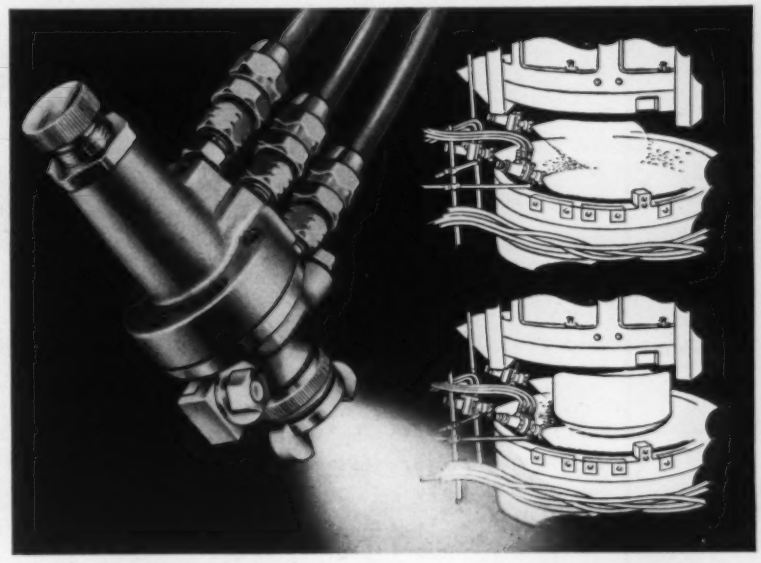
Item 448—Designed for high production machining of malleable iron pipe fittings, horizontal automatic indexing machine is a one-way, five-station unit. The parts are automatically loaded, four at a time, into the work holding fixtures at station one by a magazine type loading arrangement. They are then automatically indexed into the remaining stations where the following machine operations are performed: Two diameters are combination bored, chamfered and rough counterbored in the second station; a finish counterbore and chamfering operation is performed in the third station. The tapping operation is performed at station four and the parts are automatically unloaded in the fifth station.

The machine is designed to handle five different sizes of pipe fittings, ranging from 1¼ inch-12 thread to 2 inch-14 thread at a gross production rate of between 576 to 712 pieces per hour, depending upon the size. To accommodate these different sizes, the machine is equipped with interchangeable clamping fixtures, facilities for changing spindle speeds, and interchangeable lead screw tapping spindles for the different thread leads. **Greenlee Bros. & Co.**, 2136 12th St., Rockford, Ill. —*Circle 448.

*For Inquiry Card, see page 17

Automatically sprayed-on drawing compounds cut metal-forming costs

NEW DEVILBISS METHOD SAVES COMPOUND, COATS EVERY PART EXACTLY ALIKE, IS FULLY AUTOMATIC



Split-second timing. *DeVilbiss WDB automatic guns spray exact amounts of drawing compound evenly over specific areas of die, as it opens and closes. To synchronize spray with press cycle, cam-actuated air valve is worked off the ram. In other instances, a solenoid air valve is actuated by chain-drive timer, operating off gear wheel.*

Now you can cut stamping costs, increase production rates, get uniform application of drawing compound in your production of stamped or formed metals. DeVilbiss spray method and versatile spray guns eliminate wasteful swabbing, rolling, or dripping lubricants – save you time and money!

DeVilbiss WDB Gun is designed and built specially for applying die lubricants. It is compact, durable; sprays all types of compounds – from the lightest oil to the thickest creamy or foamed materials. Spray pattern is completely adjustable, from a fine round shape for narrow stock, to a broad fan for wide surfaces. The gun is built to maintain precise, constant rate of application; is easy to install, and offers low maintenance.

For full details, see your nearest supplier today; or write us direct. *The DeVilbiss Company, Toledo 1, Ohio.*

FOR BETTER SERVICE, BUY
DEVILBISS

DEVILBISS HELPS YOU GET THE MOST FROM THE SPRAY METHOD

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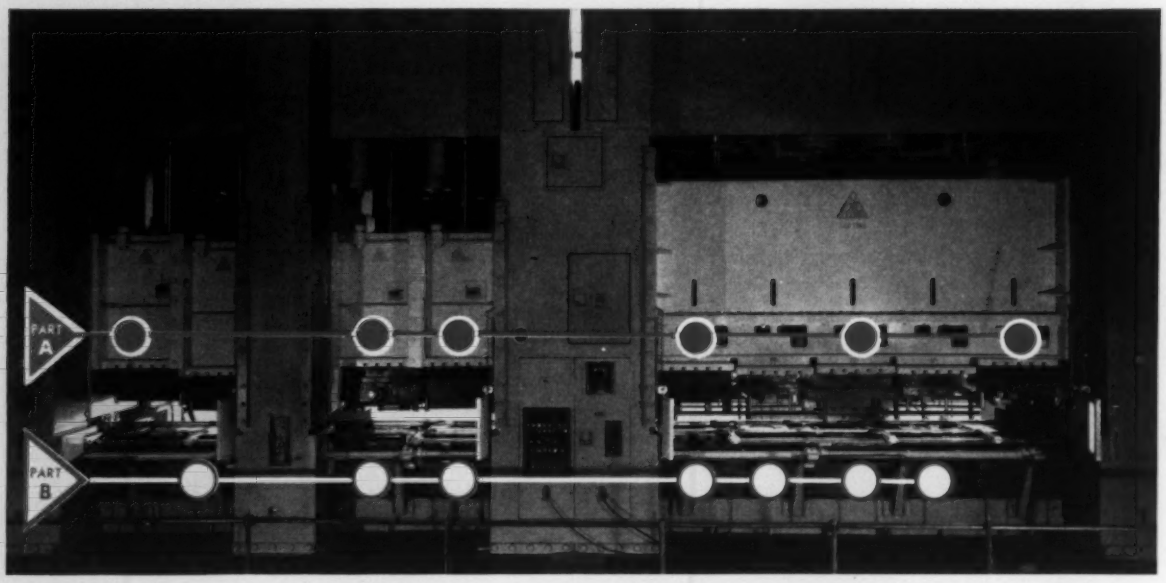


A Clearing modular press equipped with one large single slide and two pairs of split slides produces washer tops for several hours, then converts in minutes to producing dryer tops.

QUESTION: HOW CAN CLEARING TRANSFLEX SLIDE PRESSES HELP YOU BEAT THE COST SQUEEZE?

ANSWER: BY PROVIDING A WHOLE NEW BAG OF TRICKS THAT WILL INCREASE YOUR PLANT'S PRODUCTIVITY.

Q. Does operating a Clearing multiple slide press present a major advantage over automating a number of individual presses?

A. Individual presses will do the job. However, the main advantage with a single, multiple slide machine lies in greatly increased productive potential because it can operate continuously. Then too, there's the lower initial cost and lower operating costs of running a single machine—less manpower, less floor space required, less overhead.

Q. Why multiple slides rather than a single large slide?

A. Multiple slides make it possible to correct unbalanced loading—a more or less natural condition when trying to run a number of dies in a single press.

Q. What are split slides?

A. Split slides are actually two individual slide elements placed side by side between a common pair of uprights. They provide for unbalanced load conditions and facilitate almost instant production changeover by making it possible to adjust dies into, or out of, the operation.

Q. What about skip stroke?

A. Skip stroke enables a manufacturer to produce two parts at alternate strokes of the same machine. The slide has an internal mechanism which raises the punch at every second stroke so that parts passing through these stations are untouched. Split stroke combined with split slides makes a number of production combinations possible.

Q. How about sub-slides?

A. Sub slides are a good way to individually adjust dies on a single large slide. Sub-slides are another way to make quick production changes by manipulating slide adjustments.

Q. Is there more detailed information available on Clearing Transflex slide arrangements?

A. Just write us. We'll send our bulletin SB33.48 without delay.

CLEARING PRESSES THE WAY TO EFFICIENT MASS PRODUCTION

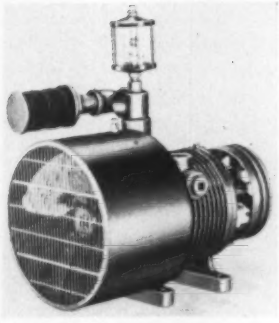
CLEARING MACHINE CORPORATION *division of* **U. S. INDUSTRIES, INC.**

6499 W. 65th STREET • CHICAGO 38, ILLINOIS • HAMILTON PLANT • HAMILTON, OHIO

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

For detailed information and literature, use card page 17

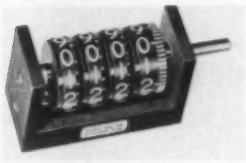


Rotary Pump

Item 499—Designed for continuous, heavy duty service as either a compressor or vacuum pump, Model 4565 rotary vane air pump delivers 45 cfm. The unit is air-cooled by a 10-inch pitch diameter fan externally mounted on a rear-end shaft extension. Air is directed by a combination cowl and fan guard, eliminating the complications due to water cooling.

As a compressor, with V-belt drive at 1750 rpm, the unit delivers 20 psig continuously with a 5 hp motor. For lower pressures and for vacuum to 25 inches Hg, a 3 hp motor is recommended. Where displacements of 35 cfm or less are adequate, the pump may be operated at 1350 rpm, with a 2 or 3 hp motor. Five composition vanes slide in slots milled and ground in the cast iron rotor.

As a compressor, the unit includes 1-inch pipe size automatic lubricator and felt type intake filter, adapted to such applications as atomizing No. 5 or 6 fuel oil on industrial oil burners for packaged boilers, etc. Used as a source of air pressure independent of plant air lines, the pulseless air delivery of rotary design eliminates need for an air tank. As a dry vacuum pump with 45 cfm capacity, the unit can be used instead of two smaller pumps on original equipment applications such as paper or sheet feeding on printing presses, or on packaging and bottle filling machinery. **Gast Mfg. Corp.**, Benton Harbor, Mich.—*Circle 499.



Readout Counters

Item 501—Applicable as readout indicators on missile tracking devices, navigation instruments, radar controls, computers and other instrument and electronic applications, counters are designated the D Series. The series is comprised of 28 different models, each with identical configuration of case, wheels and components, affording continuity throughout various types of equipment. Model variations are: single-bank readout counters from three to six figures capacity with single-width unit wheel, and three to five figures capacity with 1½-width unit wheel. They are available with right or left hand drive.

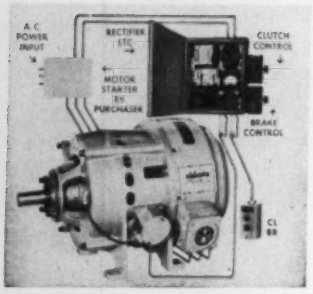
A feature of the counter design is the use of one-piece nylon wheels running with Nylatron pinions, which provides for higher speeds with less noise, less torque, and longer life. It also reduces the moment of inertia and provides a lighter counter in total weight. **Durant Mfg. Co.**, 1997 N. Buffum St., Milwaukee 1, Wis.—*Circle 501.

Four-Way Valve

Item 509—Developed for fast, smooth operation of double-action cylinders, four-way five-port valves are called Quick-Dump devices. There are no internal springs, packings, pistons, or sliding metal-to-metal contacts. Two Quick-Dump models are electrically operated. They do not employ solenoids, but have electromagnetic armatures. Armature travel in actuating the valve is only 0.022-inch. The short throw eliminates hammering action and reduces wear.

One of the electric valves is a momentary impulse type. A single electric impulse opens one valve section and closes the other. The valve then stays in this position until a second electrical impulse returns it to the opposite position. Electricity is used for impulse only; no current is required to hold in either position. The second electric valve of the fail-safe type holds as long as current is on, and returns to normal or original position when electricity is shut off. A third type is a hand lever model for mounting on bench, machine, at the production line station, etc. **Humphrey Products Div., General Gas Light Co.**, Kalamazoo, Mich. —*Circle 509.

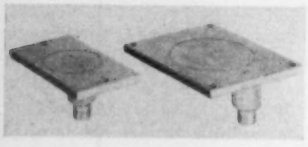
*For Inquiry Card, see page 17



Package Drive

Item 511—Fast or slow starts with acceleration, deceleration and/or stops in automatic cycles up to 30 per minute are provided by package motor-clutch-brake drive. Designed around a Fairbanks-Morse axial air gap motor closely coupled to magnetic clutch and brake components, the unit is available in 1½ through 15 hp sizes, all with constant torque and at standard motor speeds between 600 and 1800 rpm. Maximum diameter is 18 inches, with overall drive length no greater than 30 inches. The device is available as a standard unit with dc rectification incorporated and with special control cabinet for automatic cycling.

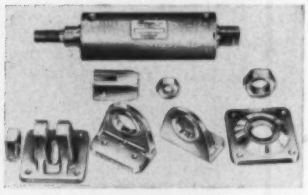
The drive operates veneer clippers, shearing and punching machines, conveyors, indexing tables and other machinery under continuous or intermittent service, with almost any desired combination of automatic stop-start or speed - up, slow - down regulation. The clutch magnets produce maximum torque on low dc voltage (6 to 12v) and current (3 to 4 amp). **Ericsson Merritt Inc.**, 534 Pine St., Lockport, N. Y.—*Circle 511.



Pancake Pickup

Item 512 — Developed for use with proximity transducer systems, pancake pickup is called Model 4925-AN. The unit is designed to sense larger metallic masses at a greater distance. Available in coil sizes up to 12 inches and larger, the pickup provides extra sensitivity through use of the larger coil.

The device operates at maximum efficiency when used for sensing specific objects and functions over a range approximately equal to the radius of the coil. The pickup utilizes a disk-like coil mounted on heavy bakelite stock; it operates under conditions of oil, dust, moisture, vibration and a wide variety of temperatures. **Electro Products Laboratories,** 4500 N. Ravenswood Ave., Chicago 40, Ill.—*Circle 512.

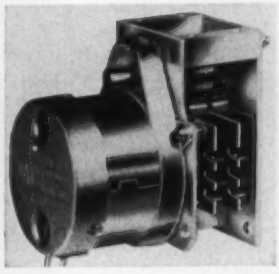


Compact Cylinders

Item 535—For air or hydraulic service to 200 psi, compact Economair series cylinders are now available in 1½ and 4-inch bore sizes in addition to the 1⅛, 2, and 3-inch sizes in the original line. The cylinders feature internal feed ring locking of heads to cylinder barrels which eliminates bulky head castings. Flange, clevis or L-type mounting brackets are interchangeable. The barrels are of hard drawn seamless brass tube, rods of ground and polished stainless steel, heads and pistons of aluminum. **Modernair Corp.**, 400 Preda St., San Leandro, Calif. —*Circle 535.

Repeat Cycle Timers

Item 508—Comprised of a motor turning a camshaft which actuates switches in a predetermined sequence and repeats continuously, miniature repeat cycle timers are available with cycling times from 1 to 24 hours, depending on the motor used. Timing accuracy is determined by the accuracy of the timing motor, which in turn is dependent upon line frequency or line voltage. When close tolerances are required, chronometrically governed dc motors maintain accurate



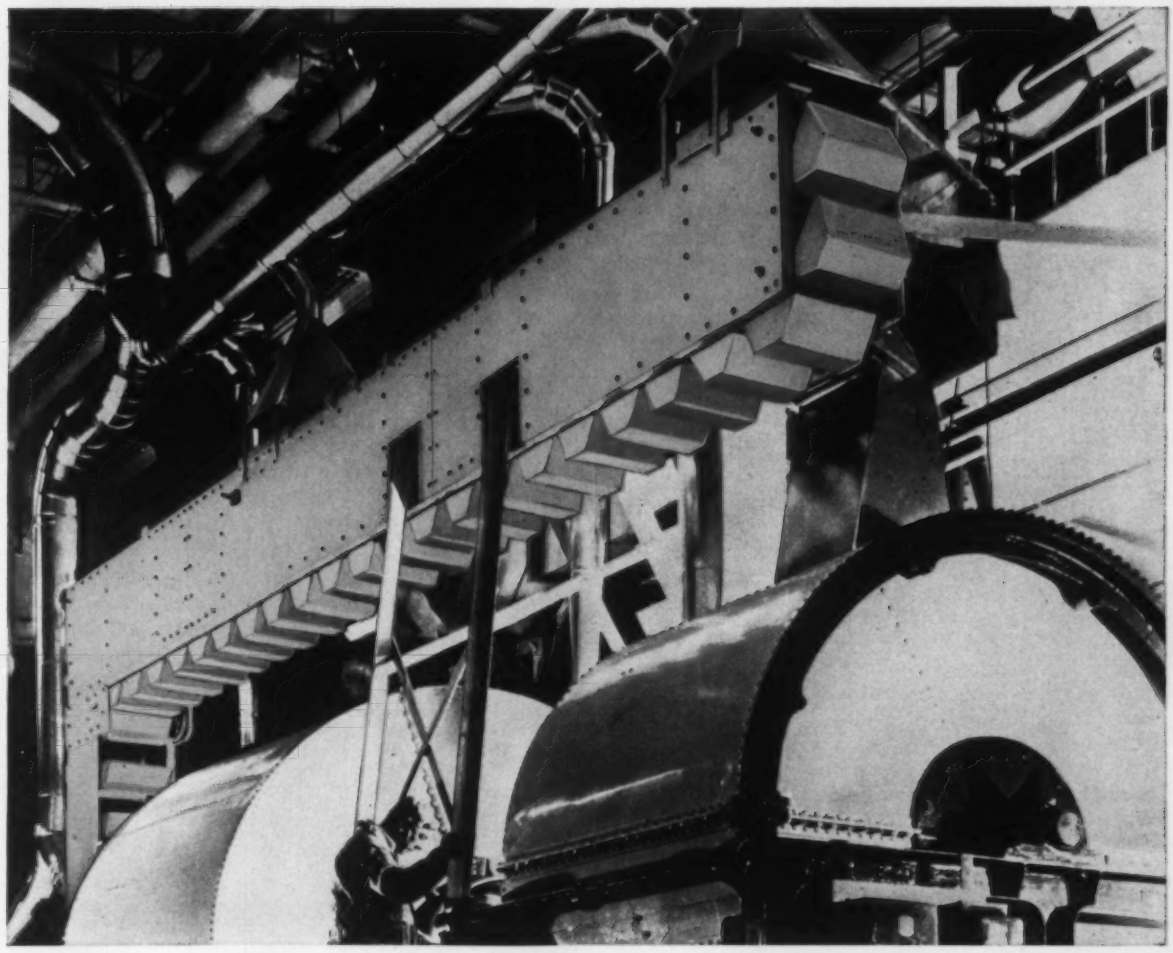
speed over a wide voltage range. Accuracy of cam setting is specified as ± 6 degrees. Timers meet various military specifications, including a provision for radio noise filter where desired on dc units. Materials and finishes are either corrosion resistant in themselves, or treated to resist corrosion. **A. W. Haydon Co.**, Waterbury, Conn. —*Circle 508.

Packaged Controls

Item 527 — Two new chassis styles, designed for use in original equipment, are features of packaged Simplytrol and Versatrol controls. The chassis, designated Minimum-Frontal-Panelmount and Silhouette, are furnished without side or top panels. Most components are individually covered. Available with all standard control circuits and components, the chassis styles are intended for built-in flush mounted applications where space saving is important.

Contact meter relays used in the controls are 4½ inches wide. Chassis are 4½ inches wide and 7⅜ inches deep. Panel of the Minimum-Frontal-Panelmount is 5½ inches wide and 5 inches high. The front panel of the MFP may include *On-Off* switches and indicating lights. Switches for the Silhouette are mounted through the panel in which the unit is placed. **Assembly Products Inc.**, Chesterland, O.—*Circle 527.

*For Inquiry Card, see page 17



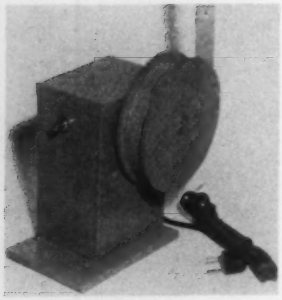
BUCKET LIFT CONVEYING FOR ANY BULK FEEDING OPERATION

Robo-Lift moves any bulk material horizontally and vertically... gently and without costly rehandling. Gentle filling-without-scooping makes Robo-Lift suited for handling foods, drugs, compounds, powdered metals and components. Each installation is custom designed for integration with existing production and packaging machinery. In photo above, Robo-Lift carries dry tea. One man controls discharge of tea into both blenders to bring new speed and economy to this batch operation. Our new folder describes the advantages of Robo-Lift. Write today for your copy of "Up...and Over!"

Address Inquiry to Dept. A.

ROBO-LIFT BUCKET ELEVATING CONVEYORS

LYNCH ROBO
CORPORATION
A Division of
LYNCH CORPORATION
Anderson, Indiana



Tape Winder

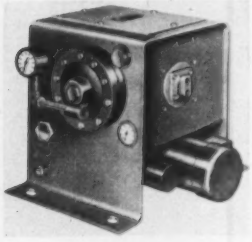
Item 533 — For handling tape either from a tape punch or a reader, Tape-File electric tape winder can also be fitted to rewind adding machine tapes and is easily adaptable to teletype systems. A feature of the device is that the entire winding reel may be removed from the unit for subsequent data processing, shipping, rewinding and storage. A removable face reel can be used where preferable.

Designated Model 3055, the electric power winder is designed to maintain a constant tension on tape as it flows intermittently from punching equipment, without damage to the tape or the motor of the unit. The winder requires a 110v circuit. **Dresser Products Inc.**, 152 Wheeler Ave., Providence 5, R. I.—*Circle 533.

Blending Control

Item 497—Used to accurately maintain flow rates in closed loop systems or to blend and proportion in open loop systems, electronic blending control device is called the Blendtrol. It is designed to handle a wide variety of products including oils, inhibitors, solvents, soaps, waxes, etc. The controller may be located several thousand feet from the process. It avoids the necessity of piping the components to the control station.

In a typical proportioning application, a flow rate meter transmits to the Blendtrol an electric signal proportional to the flow rate of the major component. The desired percentage of the additive is set in on the Blendtrol ratio dial. The preset ratio is maintained, regardless of flow rate variations of the major component. The Blendtrol is designed to be adapted to proportioning systems currently in operation. **Jordan Co. Inc.**, 3235 W. Hampton Ave., Milwaukee 9, Wis.—*Circle 497.



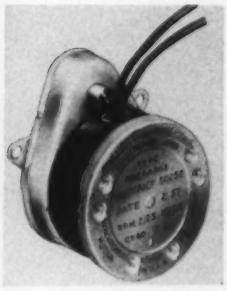
Edge Guide Unit

Item 539—For light duty service in the rubber, plastics, textile and paper converting fields, edge guide unit comprises a self-contained regulator, motor, pump and oil supply. Designated Model 550, the unit is furnished with a pressure operated shut-off valve which provides automatic locking of the control cylinder on stopping of the pump motor.

The motor is of the 1/6-hp, totally enclosed ball bearing type. When not otherwise specified, the hydraulic control cylinder is furnished with 2-inch bore, 6-inch stroke, foot mounted with rod clevis. The cylinder is also available in strokes of 4 and 6 inches. The sensing nozzle with built-in air purge is suitable for all types of applications where dust or foreign particles are present in the atmosphere. **Askania Regulator Co.**, 240 E. Ontario St., Chicago 11, Ill.—*Circle 539.

Synchronous Motor

Item 503—Used in instrumentation and automatic controls, vending machines or any device in which accurate drive is necessary, high torque, permanent magnet synchronous motor is designated Type 114. The motor features



guaranteed torque of 30 inch-oz at 1 rpm, a selection of speeds from 60 rpm to ½-revolution per day, and rapid delivery on orders of all quantities.

The motor can be provided with a variety of output shaft dimensions. Instant start and stop, low input and permanent lubrication are other features of the device. The motor operates on all standard ac voltages, 50 and 60 cycles. **Cramer Controls Corp.**, Centerbrook, Conn.—*Circle 503.

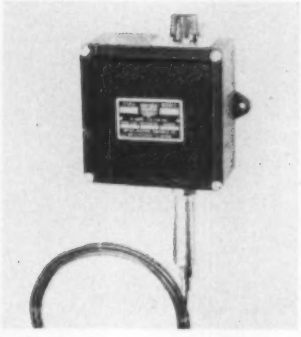
Speed Transmitter

Item 510—Applicable to turbines, conveyor lines, compressors and mill equipment, Type 16A pneumatic speed transmitter produces a pneumatic output linearly proportional to rotational speed. It measures the speed of any rotating machinery. The transmitter operates on the force balance principle with magnetic actuation of a standard pneumatic circuit.

Connected to rotating equipment, the transmitter input shaft spins a multipole permanent magnet, rotating a magnetic field through a nonmagnetic disk close to the magnet poles. The disk, with a force bar attached, tends to rotate in the same direction as the magnet, positioning the bar in relation to the air nozzle. The result-

*For Inquiry Card, see page 17

ing back pressure in the nozzle circuit, amplified by a relay, exerts force through a free-floating ball piston which bears on the force bar, to balance the torque produced on the disk by the rotating magnet. The 3 to 15 psig feedback pressure is received by an indicator, recorder or controller calibrated in units of speed. **Foxboro Co.**, Foxboro, Mass.—*Circle 510.



Temperature Control

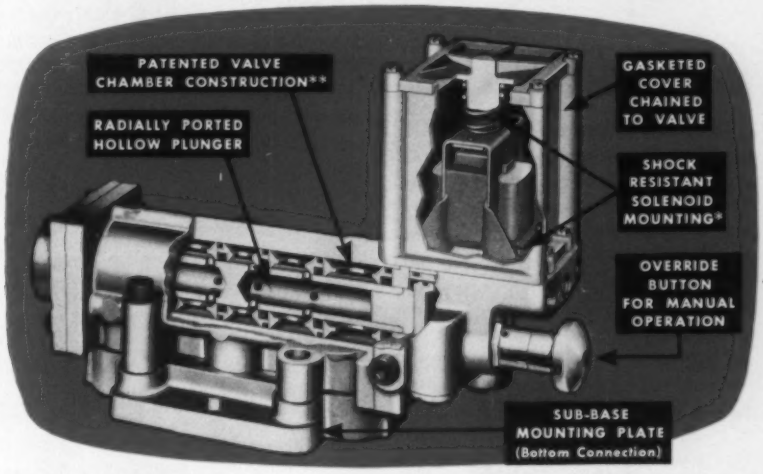
Item 519—Used in water baths, incubators, hot plate presses, cooling cabinets, air conditioning, food and drink vending machines, etc., remote bulb calibrated temperature control is designated Type E13. The bulb is exposed to the controlled medium, and the control head with its attached bellows is the controlling device. A capillary tube connects between the bulb and the bellows. The bulb, capillary tube and bellows are all liquid filled, and the temperature change in the bulb is converted to a volume change in the liquid. This in turn produces a linear motion in the bellows plunger, which operates a switch at a preset temperature.

Models are available with range spans of 100 or 200F between limits of −150 and 650F, and *On-Off* differentials of approximately 1 and 2F. The control can be supplied with any one of three standard types of switches: Normally open, normally closed, or double-throw with no neutral position. **United Electric Controls Co.**, 79 School St., Watertown, Mass. —*Circle 519.

*For Inquiry Card, see page 17

Quick-As-Wink®

JIC 1/2" TYPE BJ SOLENOID VALVES


PATENTED VALVE CHAMBER CONSTRUCTION**
RADIALLY PORTED HOLLOW PLUNGER
GASKETED COVER CHAINED TO VALVE
SHOCK RESISTANT SOLENOID MOUNTING*
OVERRIDE BUTTON FOR MANUAL OPERATION
SUB-BASE MOUNTING PLATE (Bottom Connection)

offer users many outstanding advantages

Painstakingly designed, ruggedly built and tested for more than 4 years, these new JIC Quick-As-Wink valves combine: —

1) **HIGH FLOW CAPACITY.** The valves have full ½" pipe capacity.
2) **SHOCK RESISTANT SOLENOID MOUNTING***. Positioning the solenoid with a spring on resilient rubber rings reduces destructive hammering and pounding, greatly increasing solenoid life.
3) **DIE CAST ALUMINUM COVERS** are fully gasketed, mounted with captive screws, and fastened to the valve with a chain.
4) **SUB-BASE MOUNTING PLATE.** Available in two designs so that pipe connections can be made through the bottom or through the side.
5) **PATENTED VALVE CHAMBERS** are formed by aluminum spacers in accurate metal to metal end abutment** that hold the "O" rings and "U" packers in exact position, and supported on both inside and outside diameters, without mechanical pressure. This proven construction permits repacking easily, quickly and accurately in the field.
6) **OVERRIDE BUTTON** permits manual operation in case of power failure.

MANY OTHER OUTSTANDING FEATURES

Also available in 2 position and 3 position Double Solenoid;—2 position and 3 position Lever Operated;—and Single and Double Pilot Operated Designs.

Get full details about this new valve. Write for Bulletin No. 571—Today!

*Patent Applied For **U. S. Patent 2,645,450

Quick-As-Wink®
AIR AND HYDRAULIC
Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 2075 East Pershing St., Salem, Ohio

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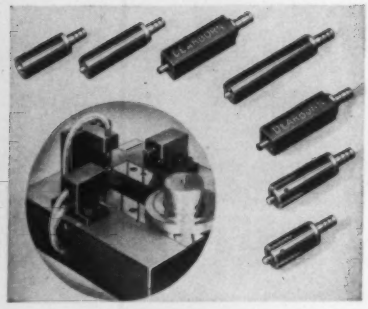
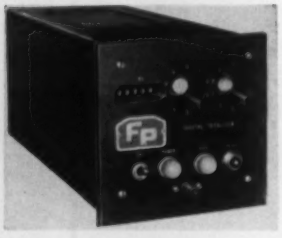


Air Gage Cartridges

Item 513—Used in checking hard to reach surfaces and relationship dimensions involving outside diameters, inside diameters, steps, eccentricity, concentricity, flatness, parallelism and similar gaging applications, line of multiple amplification contact air gage cartridges is designed for interchangeable use on any make or type of air gage instrument. Their interchangeable use eliminates the need for using a specific cartridge for a specific tolerance range, and reduces the size of inventory required.

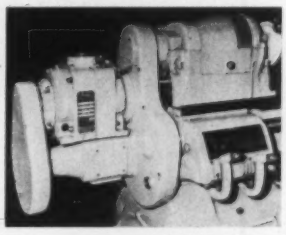
The line includes normal, short normal and reverse cartridges which can be used interchangeably for 1500, 3000 and 6000 to 1 amplification ranges. In addition, a long range, low amplification cartridge for 15.000, 30,000 and 60,000 to 1 amplification ranges, plus a square body type cartridge for simple fixturing applications are also offered. **Air Gage Div., Dearborn Gage Co.**, 22038 Beech St., Dearborn 8, Mich.—*Circle 513.



Digital Totalizer

Item 530—Designed for use with F&P turbine flow meters, digital flow totalizer can also accept balanced 500 ohm inputs from any similar signal sources. Output from a turbine meter is continuously presented on a seven-digit register—a five-digit mechanical counter plus a two-digit electronic counter — showing total pulses, counts or cycles. The indicated count, multiplied by a constant, equals total flow in the desired units.

Accuracy of the totalizer is ±1 count. System accuracy, when the totalizer is used with the F&P turbine meter, is ±0.5 per cent of indicated total. Counting rate ranges from 20 to 1000 cycles per second. Power requirements are nominally 50w (115v, 60 cycles). Controls permit manual reset of external reset and gating. **Fischer & Porter Co.**, 952 Jacksonville Rd., Hatboro, Pa.—*Circle 530.



Traverse Drive

Item 496—Designed for traverse applications on winding machinery, variable speed transmission provides infinite speed range with accuracy of speed holding and speed reset. It maintains preset speed ratio between output and input shaft in spite of wide fluctuations of input speed, including jogging, fast acceleration and deceleration. Special controls can be used to change traverse rates according to a predetermined schedule.

Traverse rates can be set in on a counter type traverse rate indicator having expanded readings at low ratios of output to input speed. Since fine wire requires traverse at very low speed, and since traverse rates are most critical with fine wires, an expanded speed scale at minimum speeds is desirable.

The traverse drive is available with a variety of built-in reducers of both spur and worm gear types having output shafts horizontal or vertical up or down. Low inertia of the output assembly plus a special spring load construction insures maintenance of output to input shaft ratios. Other units with built-in motors are suited for spindle drives. A traverse drive with micrometer adjustment is illustrated installed on a coil winding lathe designed to manufacture precision multiturn potentiometers. **Graham Transmissions Inc.**, Menomonee Falls, Wis.—*Circle 496.

Speed Controller

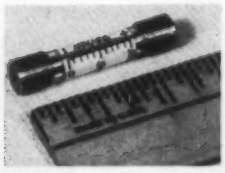
Item 531—Acceleration and speed control of shunt wound, dc motors ranging from 1/50 to ¼-hp is provided by Model CX25 electronic controller. By means of the acceleration control, the motor can be brought to any speed from 1 to 2200 rpm either immediately or gradually over a ½-minute interval. This feature is important with windings of fine wire and filaments that break when subjected to sudden tension.

The fine speed adjustment works in conjunction with the coarse speed control. Motor speed may be accurately and steplessly varied by as little as 220 rpm with 270 degrees of speed potentiometer rotation. **Gerald K. Heller Co.**, 1819 Industrial Rd., Las Vegas, Nev. —*Circle 531.

Elapsed Time Indicator

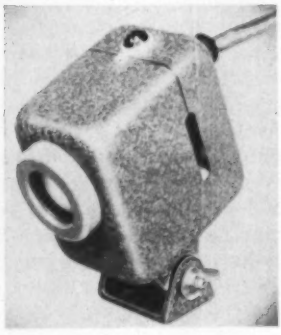
Item 515—Used for indicating the total number of hours during which any electrical instrument, appliance or component has been in operation, miniature electrochemical elapsed time indicator is called the Chronistor. The device operates on an electroplating principle, and is actually a miniature electroplating bath containing an

*For Inquiry Card, see page 17



anode, cathode and electrolyte. A small amount of current is required by the unit since it is timed; no auxiliary relays or switches are necessary.

Applications of the time indicator include determining periodic overhaul times; determining component replacement periods; warranty of instruments or equipment; encouraging replacement of expendable units such as heater elements, batteries, etc.; and life test timing. **Bergen Laboratories,** 247 Crooks Ave., Clifton, N. J.—*Circle 515.

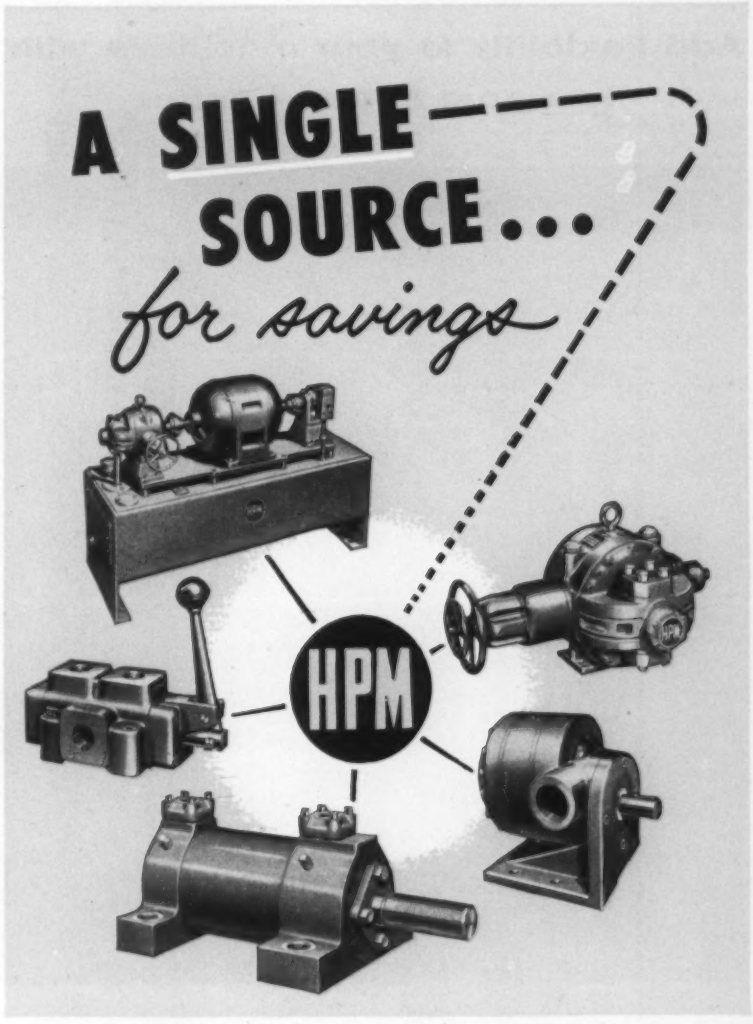


Light Projector

Item 517—Used in photoelectric applications, light projector features small size and long bulb life, with projection distances up to 8 ft. The projector has a simple lens system used in conjunction with a confined 4 cp filament lamp. The removable lens mounting ring allows light slit masks to be incorporated. A jeweled indicator serves as a warning in case of lamp failure. The self-contained limiting resistor provides lamp life expectancy of 1500 hours.

Model 6300 projector (illustrated) is designed for 6.3v ac or dc input. An identical projector, Model 6275, operates on 12v ac or dc. **Autron Engineering Inc.,** 1254 W. Sixth St., Los Angeles 17, Calif, —*Circle 517.

*For Inquiry Card, see page 17



Buying component parts from one supplier can save a lot of time and trouble . . . less correspondence, a single responsibility, coordinated shipments are only a few of the many advantages. H-P-M's complete line of pumps, power units, valves, cylinders and system accessories can become your standard. This complete service plus H-P-M's experience background in the design and building of hydraulic systems can be a really major "assist" when needed. Write today for a complete catalog and get the facts on single source savings. Ask for Bulletin 1101.

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MAXIMUM TO MINIMUM OUTPUT SPEED POSITIONS

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Vari-Speed Motor Pulley

Get greater productivity . . . run at the most economical production speed . . . handle production or process variables with the same machine—install low-cost REEVES Vari-Speed Motor Pulleys!

Change machine output speeds . . . instantly and accurately . . . without interrupting production. Positive "close-grooving" lubrication assures free sliding discs for *easy, sure* speed adjustment. Minimum parts mean long, trouble-free service.

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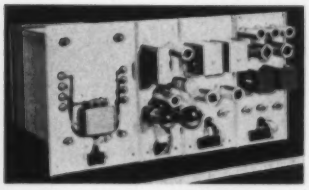
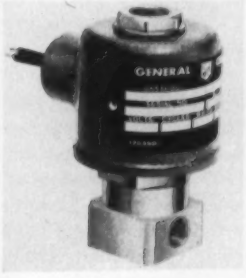


Automatic Systems

Item 514—Automatic size control, automatic gaging and automatic inspection and classifying can be added to standard machines by systems which are combinations of seven standard components. The systems are designed to fit specific customer requirements.

A typical application of a system to a through-feed centerless grinder includes a meter type size indicator, transducer head of the comparator type for size control, servomotors, electronic classifier for operating reject gates and shutoff, and magnetic power amplifier which provides amplification to the preamplifier sufficient to drive the servomotors. The seventh component in the system is a regulated electronic power supply. The systems are applicable to both existing and new installations. **Cargill Detroit Corp.**, Birmingham, Mich.—*Circle 514.



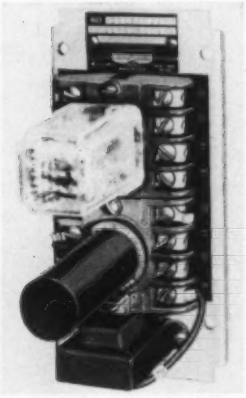
Solenoid Valve

Item 498—Suitable for use on all common industrial fluids, including water, oil, gas and air at operating pressures up to 130 psi, small solenoid valve has applications in gas or liquid flow control in automatic production machinery, process controllers, test benches, spraying and lubricating equipment. The shutoff valve is 3⅛ inches high

*For Inquiry Card, see page 17

and 1⅞ inches in diameter.

Known as the K-27H, the valve is available in ⅛-inch pipe size and is normally closed. It features a spring-loaded plunger with soft seat for bubble-tight shutoff, brass bar stock body and two-wire continuous duty solenoid. **General Controls Co.**, 801 Allen Ave., Glendale 1, Calif.—*Circle 498.

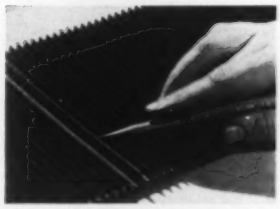


AC Sensitive Relay

Item 505—Low capacity contact making devices such as drop wires, feeler switches and gages, contact making instruments, sensitive thermostats and slow-make, slow-break contacts, operate without electrical damage through the use of an ac sensitive relay with transistor amplifier. The unit is designed to resist vibration, corrosion and shock and features a two-pole, double-throw plug-in relay protected by a dustproof cover; a plug-in transistor amplifier and power pack module; 12v dc sensing circuit and a low sensing circuit current (less than 0.002-amp).

The high speed operation of the relay makes it desirable for use in stop motion or sorting circuits. The low voltage noninductive circuit results in no visible arc and thus eliminates fire hazards on applications where the sensing contacts must be near flammable material. Long distance remote control, liquid level control and photocell applications are also possible.

Rated up to 10 amp, 110v, the relay is available in an open type panel or NEMA type 1 bonderized general purpose enclosure. **Cutler-Hammer Inc.**, 378 N. 12th St., Milwaukee, Wis.—*Circle 505.



Ribbed Conveyor Belt

Item 506—Designed for steep-angle conveyor operations in stores, factories, warehouses and shipping rooms that handle both light and heavy merchandise packages, ribbed conveyor belt is called Griptite. Both light and heavy packages are held firmly in place by a series of inverted V-shaped ribs that grip the cartons in either incline or decline operations.

Extra protection for holding extremely lightweight packages in place is provided by raised ribs or cleats spaced 18 inches apart. The standard ribs are ¼-inch high

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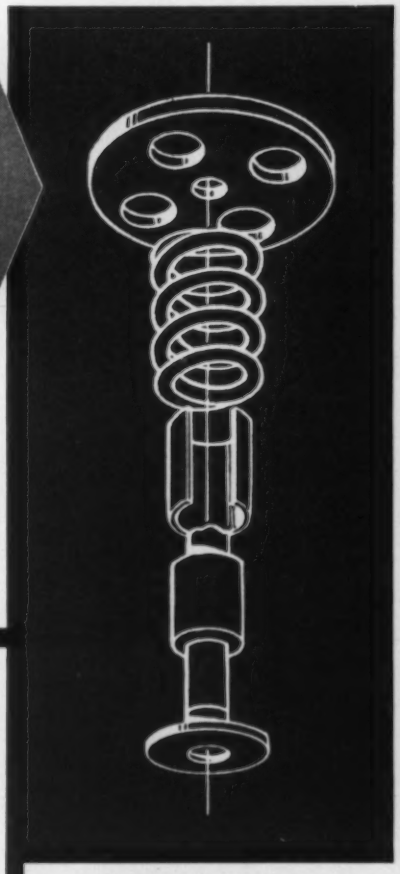

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This five-part valve insert is assembled, fastened, counted and marked at the rate of 1800 per hour in an eight-station assembly machine designed and built by Gray Equipment Co.

Is Automation Best for You?—Gray engineers will evaluate your problem objectively.

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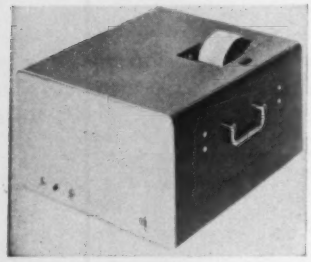
and are spaced four to the inch. The raised ribs, which also help move packages onto the belt, are ⅜-inch high. **B. F. Goodrich Industrial Products Co.**, Akron, O. —*Circle 506.



Digital Printer

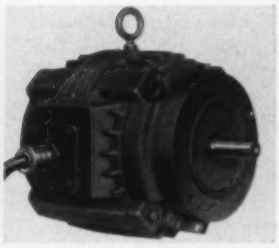
Item 524—Converting count information into printed form is the function of the Model 400A high speed digital printer. Featuring rapid print-out, parallel entry, and up to 12-digit printing, the unit uses no stepping switches. It can be connected directly to other electronic counting instruments and will print, on standard adding machine tape, the total count accumulated by the basic instrument during each of its counting periods.

The printer operates from four-line, 1-2-2-4 binary code, and thus may be used with most existing counting equipment without modification. It is well suited for use with CMC universal counter-timers, frequency-period counters, time interval meters, totalizing counters, preset controllers and time-function translators. **Computer-Measurements Corp.**, 5528 Vineland Ave., N. Hollywood, Calif. —*Circle 524.

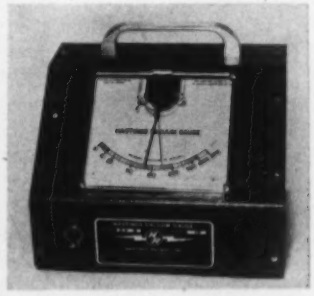
Air-Over Motor

Item 534 — Line of totally enclosed ac motors is designed to produce varying horsepower according to the application of varying air velocities. This is accomplished by the cooling effect of the air flow over the motor frame created by the fan or blower it powers. Power output can thereby be increased without exceeding the rated temperature rise of the motor.

Features of the line include cast iron ribbed frame construction,



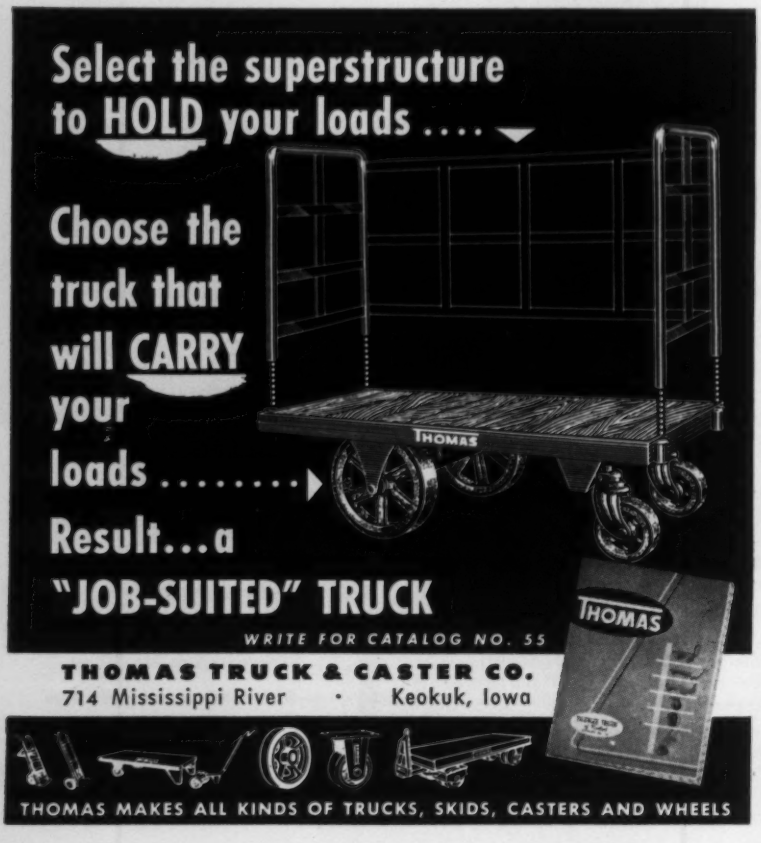
oversized double-shielded ball bearings, and Metermatic lubrication with automatic grease relief. Motors are available in new NEMA frame sizes from ½ through 30 hp and may be operated on 208v network systems. **Reliance Electric & Engineering Co.**, 24701 Euclid Ave., Cleveland 17, O.—*Circle 534.



Vacuum Gages

Item 507—Designed with single-contact relay control for auxiliary circuits, vacuum gages are available for three general-use ranges —0 to 100 microns Hg (Model CL-1); 0 to 1000 microns Hg (Model CV-1); and 0.1 to 20 mm Hg (Model CP-1). An adjustable contact arm on the meter can be preset for control at any point within the range of the instrument. Contact closes when the vacuum pressure reaches the preset position. This activates a single-pole, double-throw relay to auxiliary circuits having a total capacity up to 5 amp at 125v. The instrument continues its control until pressure is brought back into the selected range and contact released by manual reset. The relay circuit is suitable for operating pumps, alarm lights, control units, etc. The vacuum gage is a direct reading instrument. The tube is not affected by exposure to atmospheric pressure. Internal voltage regulation is provided to prevent any effect

*For Inquiry Card, see page 17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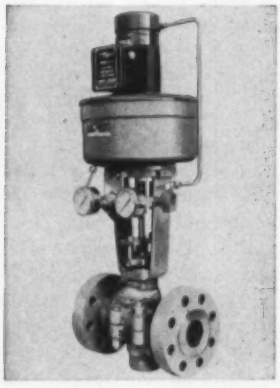
THOMAS MAKES ALL KINDS OF TRUCKS, SKIDS, CASTERS AND WHEELS

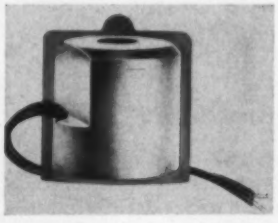
from variations in line voltage.

Advantages of the unit include upper or lower limit control, internal voltage regulation, rapid response to system changes, and direct reading logarithmic scale. **Hastings-Raydist Inc.**, Hampton, Va.—*Circle 507.



Valve Positioner

Item 538—For use with Series LB control valves, electropneumatic positioner provides valve positioning which is directly proportional to dc signals received from electronic instruments. Unit operates without transmission lag. No electropneumatic transducer is required; full 100 psi plant air supply can be used. The line of pneumatic cylinder actuated valves has single-seated, split valve bodies. **Conoflow Corp.**, 2100 Arch St., Philadelphia 3, Pa.—*Circle 538.



Solenoid Coils

Item 521 — Vacuumized and cured electronically, solenoid coil features a void-free, high-density casting. Called the Kast-Coil, the device's design provides high resistance to thermal shock and

*For Inquiry Card, see page 17

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physical abuse. It is impervious to corrosive fumes. The waterproof unit is offered for continuous service under rated conditions and carries an unconditional guarantee. **Industrial Sales Div., Dept. No. 401-A, Hays Mfg. Co.**, W. 12th St., Erie, Pa.—*Circle 521.

Air Control Valves

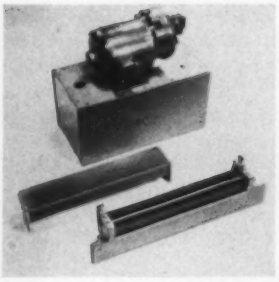
Item 536—Design for flexibility in application and long operating life are features of line of air control valves. The Starline introduces five pilot heads which are interchangeable on seven valve bodies, providing 35 major model combinations. Available pipe sizes increase the variety of combinations to 210 models.

The illustrated White Star valve is composed of a spool solenoid pilot head and any one of the seven valve bodies. Tests indicate a normal life of more than 20 million cycles for this valve. The Gold Star valve consists of one of the seven valve bodies operated by a large capacity pilot section, actuated by an oil immersed solenoid. It has a tested life of more than 40 million cycles. The Blue Star group includes all the remote piloted, pressure operated valves.

The seven valve bodies include: An in-line series consisting of straight-way, normally open and normally closed; and three-way, open and closed; plus a base-mounted series consisting of three-way, normally open and normally closed; and four-way. **Ross Operating Valve Co.**, 120 E. Golden Gate Ave., Detroit 3, Mich.—*Circle 536.

Stock Lubricator

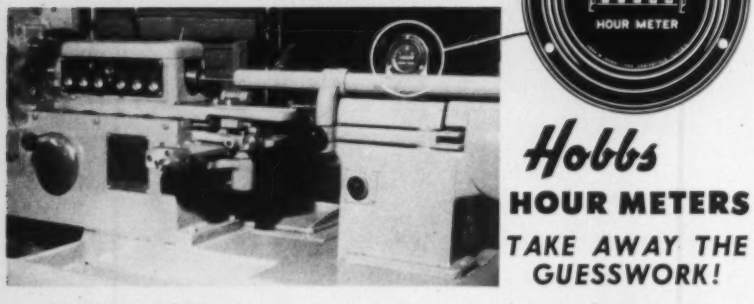
Item 504—Designed for all types of presses employing roll feeds, motorized stock lubricator assures adequate lubrication of coil stock by providing a continuous, even



amount of lubricant to the stock before it enters the press. Possibility of excessive die wear and shearing of punches is eliminated. The lubricator also controls the application of lubricant to the stock and returns excess to the tank. Use of the device affords continuous operation and minimizes downtime in high-speed automated stamping operations.

The stock lubricator has three main components—a geared pump motor, a filter or baffle tank, and a stock lubricator head. Lubricant is sprayed on the top surface and wiped on the bottom. Wiping rolls can be adjusted to control the amount of lubricant applied to the stock. Additional spray adapters can be used with the device to spray lubricant on drawing stations. **Brandes Press Co.**, 6408 Euclid Ave., Cleveland, O.—*Circle 504.

AUTOMATION REQUIRES GREATER EMPHASIS ON PROTECTIVE MAINTENANCE



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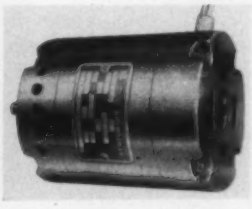


Servo Motors

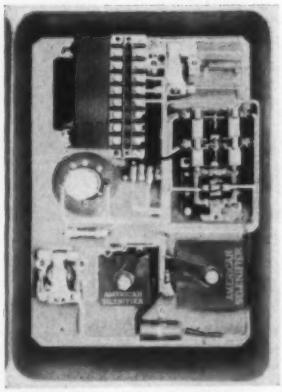
Item 532—Four new motors are designed for use with servomechanisms. The hysteresis motors, in single and dual speed, single and polyphase, are applicable where the load inertia is large compared to the motor rotor, where starting torque must be uniform in all rotor positions on single phase, and where more than one synchronous speed is required.

The second type, induction motors, are available in torque, servo

*For Inquiry Card, see page 17

and a variety of other types, and have controllable characteristics. Special windings are available for frequencies up to 1600 cycles and voltages up to 440 v. Tapped windings may also be obtained.

The ac permanent magnet generators and tachometers are used as a source for single or polyphase voltages and produce output voltage and frequency proportional to speed with a range up to 100v per 1000 rpm. The sine wave generators have a maximum range of 5v at 1000 rpm. **Syntorque Inc.**, 601 W. 26th St., New York 1, N.Y. —*Circle 532.



Electric Brake

Item 518—Developed for use on any ac motor from ¼ to 250 hp, all-electric brake is called the Selenibrake. The device can repeat its stopping cycle tens of thousands of times, making it well suited for all types of machine tools, presses of various types, printing and woodworking equipment, textile and rubber mill equipment, paper slitters and rollers.

The brake can be supplied for voltages up to 600v, either 25, 50 or 60 cycles. No connection of any kind is made to the motor itself. It is applied to the standard starter of the motor by means of six connections. The braking torque can be adjusted over a wide range to meet application requirements without the necessity of ordering a special type. **Selenibrake Div., American Rectifier Corp.**, 95 Lafayette St., New York 13, N. Y.—*Circle 518.

*For Inquiry Card, see page 17

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We designed and built the world's first automated gear chucks. These were successful immediately. Repeat orders, and production records covering millions of gears in high-production and contract gear plants alike, firmly established our reputation as the firm to see first on all jobs. This experience can be yours without cost or obligation. So—the moment the matter of automation arises—call on us. Let us engineer and build the quick-acting, trouble-free, accurate workholding fixtures which determine to some considerable extent the *output* and *quality* of parts that will be produced on your proposed automated machines.

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Tells you what's happening in the field of automation and how *you* can utilize it. Based on a series of lectures by 21 prominent scientists, this comprehensive work presents a wealth of authoritative, up-to-the-minute information on the fundamentals of automation, advances in automation techniques, and descriptions of automation system applications. Emphasis is on new developments and applications of control systems capable of performing both complex control functions and data processing. Electronics, computers, and data processing are given considerable attention.

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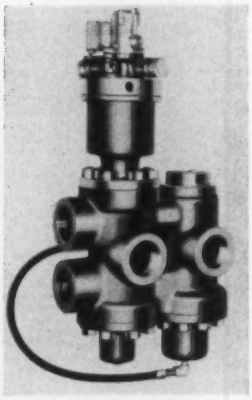
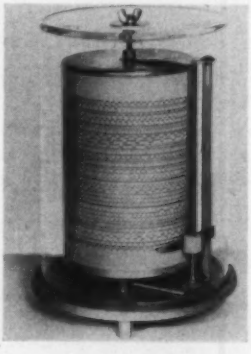


Hydraulic Valve

Item 523—For the diecasting industry, 3000 psi semiautomatic four-way hydraulic valve line is known as the E-400-X Series. The valve design provides leak-free operation with water, glycol or oil base hydraulic fluids. Activated by an integral double-acting cylinder which is controlled by a Speed King single or double solenoid pilot operated valve, the new series offers operating safety since the valve will not reverse itself in case of air or electrical supply failure.

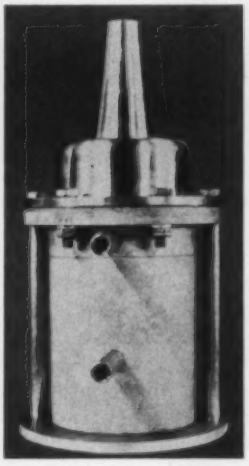
The valves are available in 1, 1½, and 2-inch NPT sizes, for line pressures up to 3000 psi. Valve actuation is afforded by 60 to 125 psi air. **Sinclair-Collins Valve Co.**, 454 Morgan Ave., Akron 11, O.—*Circle 523.



Operations Recorder

Item 525—Used on oil burners, pumps, air conditioners, alarm systems, door opening and processing equipment, MD-Jr operations recorder proves graphically when a device, machine or apparatus operates and for how long. When placed on individual machines, operation records are easily and accurately obtained. The unit shows distribution of load by machines, operations or production.

The recorder consists of a drum which rotates at speeds from 4 minutes to 24 hours per turn, as required. No ink is used; a stylus rests against the chart paper with its adherent layer of white opaque wax crystals. The pressure of the stylus exposes the contrasting color of the paper beneath. The stylus produces a spiral tracing on the chart, moving up ⅛-inch with each drum rotation. The stylus lead screw is also subject to an axial motion due to a magnet energized by the input signal to cause vertical lines. By this means, more than 400 linear inches of recording are available on the waterproof chart which is 6 by 14 inches. **Gorrell & Gorrell**, Haworth, N. J.—*Circle 525.



Ultrasonic Transducers

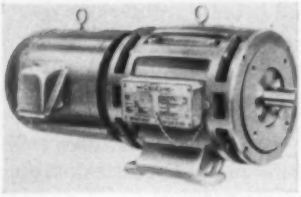
Item 528—For use in high temperature environments and for developing high amplitude ultrasonic motion such as in drilling, grinding, and particle disintegration, ultrasonic transducers are additions to a line of ultrasonic building block components. Featuring internally biased, water-cooled, 400w average to 1600w peak power magnetostrictive driving elements operating at 25kc per second, the transducers can be driven singly or in groups by appropriately rated

For Inquiry Card, see page 17

standard ultrasonic generators from 400w to 10kw and above.

The Model AT-1600 B features a cylindrical stainless steel coupling slug measuring 2 inches OD by 4 inches long. A water cooling jacket integral with the transducer cooling system extends up 12 inches to the nodal point where the slug is supported at the point of zero motion. This cooling allows the transducer to be used with the emergent face directly in contact with liquids at temperatures up to 900C. Alternately, the emergent face may be used as a vibrating platform for ultrasonic soldering and welding operations.

Model AT-1600 C features a tapered stainless steel amplitude multiplier having an emergent face with ¾-inch OD and with a tapped hole. This unit may be used for various types of ultrasonic work where large peak-to-peak amplitudes are required. When mounted in a suitable drill stand or tool holder, the transducer can be used for drilling, blanking, shaping and grinding. **Acoustica Associates Inc.,** Glenwood Landing, L.I., N.Y. —*Circle 528.



Drive & Control Unit

Item 502—Designed to provide cyclic operational functions for a machine, such as starting, stopping, inching, positioning, holding, acceleration control, deceleration control and torque limiting, power drive and cycle control device is called the Cycledyne. It is a self-contained fan-cooled package which provides fast electromagnetic stop and go action, and minimizes shock loading, power overload peaks and electrical contact arcing.

During the power drive of each cycle, the Cycledyne also functions as a power transmission. A continuously running electric motor provides driving power and kinetic en-

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Up-to-the-minute conveyor planning between automatic machines and control points is essential to gain the full benefits of automation. Your needs in conveyors — ranging from engineered systems of power and gravity types to single units — can be met by Standard. Nearly 50 years of "package" conveyor application experience is available to you. Our engineers can choose from roller, belt, slat, chain, wheel, push-bar conveyors, spiral chutes and pneumatic tube systems, plus special portable types.

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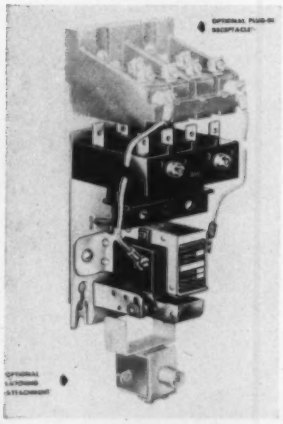
PNEUMATIC TUBE SYSTEMS

Circle 715 on Inquiry Card

ergy. The machine operational functions may be controlled by various types of remote switching devices, either automatic or manual; a choice between numerous sequencing circuits provides any extent of automation desired. The control device is provided in five basic sizes; all are available with foot, flange or face mounting options. **Cycledynamics Inc.,** 19025 W. Davison, Detroit 23, Mich.—*Circle 502.

Machine Tool Relays



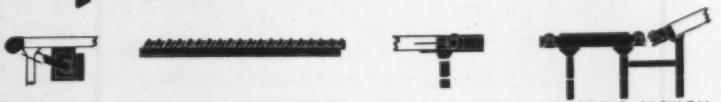
Item 529 — Offering adaptability for machine tool control applications, line of Size 0 and 00 machine tool control relays provides features for simplified installation and maintenance. The Size 00 relay is rated at 10 amp, 600v ac, and the Size 0 at 15 amp, 600v ac. Two types are available: The FMP (Fixed Multiple Pole) and the IMP (Interchangeable Multiple Pole). The latter provides an easy conversion from normally open to normally closed contacts. A center position device protects against damage to the contacts while convering.

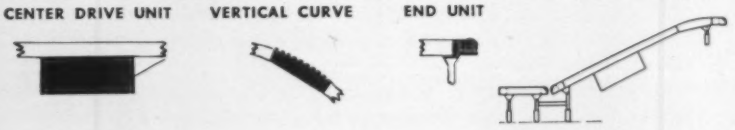
Both relay types are supplied in a complete line with two, three four, six or eight poles. An optional feature is the latching attachment which is easily added to the standard relay by means of two screws, and allows quick conversion to a latching type for use in memory, continuous duty and other similar circuits. **Arrow-Hart & Hegeman Electric Co.,** 103 Hawthorn St., Hartford 6, Conn.—*Circle 529.

Series "G"

UNIBILT BELT CONVEYORS

7 Basic units which are easily fastened together in many combinations to produce a *customer-assembled conveyor.*





LENGTHS — up to 100′
SPEEDS — 10 to 80 FPM
WIDTHS — 18″, 24″ & 30″ standard

CONSTRUCTION — 6¼″ deep formed steel channel — braced and welded throughout.

Equipment is designed to match corresponding width Live Roll and Gravity Roll Conveyors.

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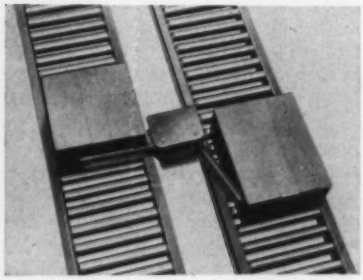
CONVEYOR SPECIALTY COMPANY, Inc.

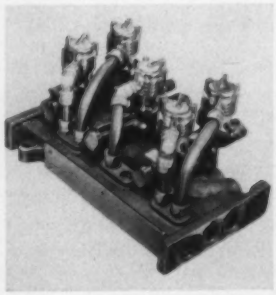
25 Newport Avenue, North Quincy 71, Mass.

Traffic Control Device

Item 500—Developed for light duty applications on converging conveyor lines, traffic control device eliminates jam-ups by automatically keeping material flowing from only one of two converging conveyor lines at a time. The device, called the Fergo-Merger Jr., controls the flow of material weighing 20 lb or less. It saves time ordinarily required to free clogged lines, keeps material moving in an even flow and speeds production, inspection, packaging and shipping operations.



The traffic control device gives the right of way to the package which reaches the intersection first, holding back the other line until the first package has cleared. The Fergo-Merger Jr. can be installed easily on power conveyors and is sensitive enough for use in gravity conveyor lines if the pitch is sufficient. **Harry J. Ferguson Co.,** Jenkintown, Pa. —*Circle 500.



Valve Manifold

Item 520 — To afford efficient multiple mounting of Speed King two, three, or four-way valves in any desired combination, manifold

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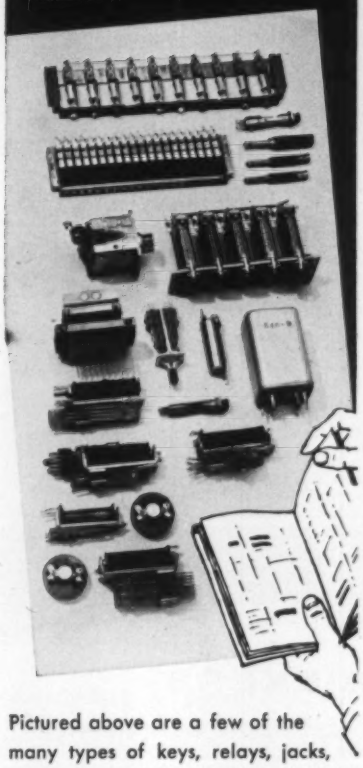
which
of these quality
COMPONENTS
do you need?



Pictured above are a few of the many types of keys, relays, jacks, plugs, and other components which Kellogg supplies to industry. 60 Years of experience stands behind the reliability of these important parts. Write today for your Kellogg Industrial Catalog.

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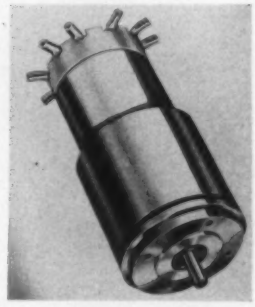
KELLOGG SWITCHBOARD AND SUPPLY CO.
A Division of
International Telephone and Telegraph Corp.
QUALITY COMPONENTS FOR INDUSTRIAL CONTROL
QUALITY COMMUNICATIONS SYSTEMS

Circle 717 on Inquiry Card

is available in two and three-station types.

The unit features full length inlet and exhaust ports, both 1 inch NPT, common to all valve stations. Electrical wiring is run through a 1¼ inch NPT conduit passage, with one access cover for all stations to simplify wiring. Pilot solenoid leads are enclosed in moisture proof flexible conduit. The manifolds are designed with side or bottom cylinder porting to facilitate piping. The manifold can be adapted to any type of control valve application. **Valvair Corp.**, 454 Morgan Ave., Akron 11, O.—*Circle 520.



Motor-Rate Generator

Item 522—Line of rotating components, Model 18 MG 690/660 device consists of a high torque-to-inertia servomotor and rate generator rotating on the same shaft and contained in a unitized housing. Motor torque at stall of 4.0 oz-inch and rotor inertia of 5.73 gm cm² result in an acceleration at stall of 49,000 radians per second².

Linear output from the generator may be applied as tachometric feedback or used as a computing element in coarse integrators. Motor and generator fixed windings operate from a 115v, 60-cycle source and can be wound for any standard carrier voltage supply. Motor control windings may be custom wound for input from various amplifiers, as required. Duty is continuous at stall, with a maximum unit operating temperature of 200C. **Beckman/Helipot Corp.**, Newport Beach, Calif.—*Circle 522.

*For Inquiry Card, see page 17

MM

MARKED IMPROVEMENTS in
IDENTIFICATION
AND DECORATION

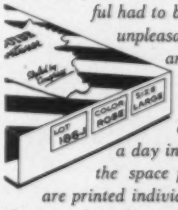
Fifteen thousand kinds of "ink"? . . .

Since 1911, Markem has developed more than 15,000 different marking compounds, and about 10,000 are currently in use. Why so many? Consider the applications: what will "stick" on polystyrene won't on cellulose acetate; what makes clear, lasting imprints on glass drug ampules is a distant chemical relative of the right marking compound for pressure-sensitive tape; and so it goes, from shoe linings to instrument dials, lipstick tubes to lollipop sticks. With all the possible combinations of drying speed, opacity, toxicity . . . liquid, paste and semi-paste forms . . . air dry, baking or high temperature . . . colors by the score —15,000 doesn't seem so fantastic. But it shows Markem's close attention to the "what"—as well as the "how"—of good marking.

Customer's name in lights . . .

A "special" version of our 20A cylindrical object marker has recently gone to work at a leading electrical plant, imprinting miniature tubular lamps with trademark, wattage, etc. Noteworthy are the feed and marking speed of these rather fragile items: up to 750 (from 4" to 7" long) are put into a hopper, then imprinted at a rate of about 2000 per hour; discharged down a chute to a firing chamber, where imprint is "baked" on. Here again, the right method provides clear marking at production rates.

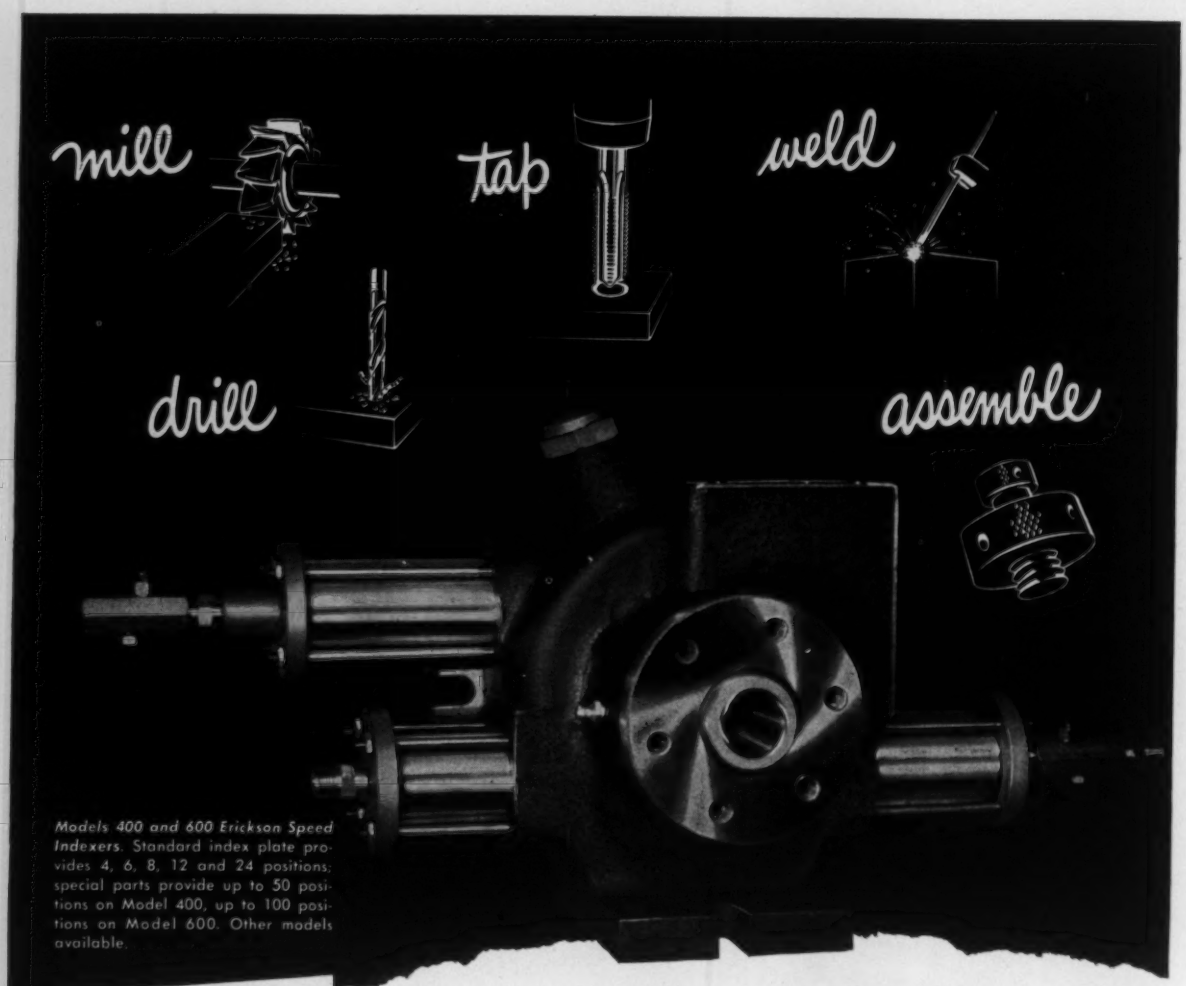
Don't keep the inspectors waiting . . . *is a cardinal rule on any production line, especially at Congress Sportswear where the final inspectors also do the packaging. But boxes were being laboriously hand stamped with the result that a whole roomful had to be kept on hand—a costly, unpleasant situation from every angle. Now with a Markem 45A box marker, imprints are made twice as fast and look far better; $5.00 a day in labor alone is saved, and the space problem is solved. Orders are printed individually, as they are needed. Goes to show how good marking can help all along the line, from production to point of sale.*



Providing better ways to decorate or identify products, parts and packages is Markem's entire business. Write Markem Machine Co., Keene 37, N.H., when you need help.

MARKEM

Circle 718 on Inquiry Card



Models 400 and 600 Erickson Speed Indexers. Standard index plate provides 4, 6, 8, 12 and 24 positions; special parts provide up to 50 positions on Model 400, up to 100 positions on Model 600. Other models available.

Angular accuracy within 2 minutes... repetitive accuracy in low "tenths" of a thousandth

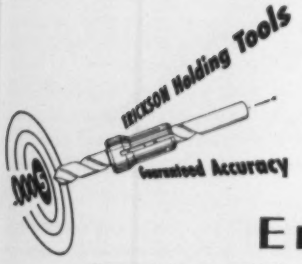
ERICKSON INDEXERS–

the economical way to smash automation bottlenecks

Even the most elaborate automatic production line can bog down *expensively* without rapid and accurate automatic parts positioning.

That's where Erickson Indexers really pay off. For you can interlock them into your production set-up with micro switches and solenoid valves. The hardened and ground lock pin operates in conjunction with the actuating mechanism to assure *positive positioning and angular accuracy within 2 minutes of a degree.* (Repetitive accuracy is no indication of angular accuracy. Erickson holds repetitive accuracy in low "tenths" of a thousandth.) And Erickson Indexers can maintain this great accuracy because their adjustable, self-contained shock control unit delivers a cushioned rotary load to the mechanism, thereby reducing wear.

Speed to keep lines moving . . . accuracy to reduce rejects . . . long life to cut maintenance and capital investment – all add up to Erickson Indexers, the *economical* way to smash automation bottlenecks.



Write for Erickson Catalog K today! You'll find many interesting applications for all Erickson holding tools. Take advantage of our free engineering service. An Erickson field engineer will gladly work with you for production economy.

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COLLET CHUCKS • FLOATING HOLDERS • TAP CHUCKS • TAP HOLDERS • AIR-OPERATED CHUCKS
EXPANDING MANDRELS • SPECIAL HOLDING FIXTURES

AA-2137

Circle 719 on Inquiry Card

catalogs and literature

Latest automation information. For copies use card page 17.

595. Speed Variations

Magnetic Amplifiers Inc., 632 Tinton Ave., New York 55, N.Y.—4-page pamphlet—Called the Magne-Speed Junior, nonelectronic variable speed drives are the subject of illustrated pamphlet. Drives are available in small fractional sizes from ⅛ to 1/100-hp. General specifications, engineering data, operational features and ordering information are included. —*Circle 595.

592. Diecasting Machines

Cleveland Automatic Machine Co., Cincinnati 12, O.—8 page bulletin—Featuring a hot chamber shot end for casting zinc, tin or lead, or cold chamber shot end for casting aluminum, brass and magnesium, four models of universal high pressure hydraulic diecasting machines are illustrated and described in bulletin. Specifications and application data are given.—*Circle 592.

598. Industrial Tapes

Minnesota Mining & Mfg. Co., Dept. L7-48, 900 Fauquier St., St. Paul 6, Minn. — 6-page pamphlet — Applications for printed and die-cut pressure sensitive tapes are illustrated and described in pamphlet. Uses include bundling, protective masking, and carrying of messages such as instructions, prices and identification. Dispensers for semiautomatic and automatic dispensing and applying of tapes are illustrated.—*Circle 598.

599. Motor Guide

Century Electric Co., 1806 Pine St., St. Louis 3, Mo.—12-page bulletin—Polyphase, single-phase and dc performance rated motors for 1/20 to 400-hp applications are included in line which is covered by Motor Application Guide 102. Bulletin includes tables which list the kind of equipment or machinery to be driven, the character of the load, and its speed of operation, indicating suitable motor types and enabling the reader to choose the correct motor for his application. Gearmotors, selective speed drives, generators and motor generator sets are also described and illustrated.—*Circle 599.

597. Electronics R & D

Designers for Industry, 4241 Fulton Parkway, Cleveland 9, O.—6-page pamphlet—Projects involving automatic testing equipment, missile guidance,, computers, radar development, data presentation, communications and control systems are included in the electronic systems research described in pamphlet. Photographs illustrate DFI facilities for electronic development.—*Circle 597.

600. Steel Tube Fittings

Weatherhead Co., 2310 Dwenger Ave., Fort Wayne, Ind.—50-page catalog—Ermeto flareless tube fittings which are used in automatic transfer machine controls, hydraulic grinding machines, steam turbine control and numerous other high pressure applications are described in catalog. Two- and three-piece Flare-Twin steel fittings are also illustrated and discussed. Assembly instructions and technical data are included.—*Circle 600.

608. Control Valves

Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.—12-page bulletin—Single-seated, split valve body design is combined with a Cylinder Conomotor actuator in design of Series LB control valves described in Bulletin LB-2. Flow characteristics, photographs and description of component parts, information on accessories and general specifications are included.—*Circle 608.

601. Refractometers

Phoenix Precision Instrument Co., 3803-05 N. Fifth St., Philadelphia 40, Pa.—8-page bulletin—Developed for end point analysis and control in the chemical, petroleum, pharmaceutical and food processing fields, automatic process refractometer is the subject of Bulletin R 1000. Instrument is used to check and control product purity, and to measure and control the blending of two streams, or the concentration of gases and solids in solutions, etc. Bulletin includes photographs of several models.—*Circle 601.

607. High Pressure Pumps

John Bean Div., Food Machinery & Chemical Corp., Lansing 4, Mich.—32-page catalog—Used to pump chemicals and abrasive materials, to process petroleum products, in central hydraulic systems, etc., line of reciprocating pumps is covered in illustrated catalog. Triplex inside packed pump and its applications are pictured. Other models shown include Triplex outside packed, Multiplex power ends, and Duplex inside packed. Accessories such as pressure regulators, relief valves, air chambers, etc. are discussed.—*Circle 607.

610. Automatic Lathes

Monarch Machine Tool Co., Sidney, O.—24-page catalog—Fully automatic cycles for turning jobs requiring one, two, three or four cuts are offered by Model 21 Mona-Matic lathe which is described in Bulletin No. 1808. Multicycle programer, air gage tracer and optional features such as automatic loading, automatic unloading and constant surface cutting speed control are illustrated and discussed. —*Circle 610.

612. Heavy Duty Limit Switches

R. B. Denison Mfg. Co., 102 St. Clair Ave., N.W., Cleveland 13, O.—8-page bulletin—Nine standard models of Loxswitch limit switches are described and illustrated in Bulletin 956. Housing, contact arrangements, wiring diagrams, ampere ratings, operating data and electrical characteristics are given for each model. Table includes 21 contact arrangements.—*Circle 612.

*For Inquiry Card, see page 17

596. Indicating Control

Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, *Pa.—8-page bulletin*—Indicating pneumatic controllers for temperature and pressure are described in Catalog C600/700-1. Temperature controller is available for ranges of temperatures between 0 and 1000F; the pressure controller ranges are from 0 to 1000 psi. Photographs and specifications of the devices are included; control unit choices include—a nonbleed pilot relay, *On-Off* control, or Throttlor control.—*Circle 596.

606. Mercury Switches

Durakool Inc., Elkhart, Ind.—14-page bulletin—Designed for durability in all fields including the switching of heavy loads and highly inductive circuits such as solenoids and motors, mercury to mercury contact switches and timer relays are covered in Bulletins No. 525 Rev. C, No. 800 Rev. B. Mercury to metal contact switches described in Bulletin No. 526 Rev. A feature usefulness in applications where small operating angles are needed. Ratings, physical dimensions and photographs of the components are included.—*Circle 606.

594. Drive Components

PIC Design Corp., Div., Benrus Watch Co. Inc., 477 *Atlantic Ave., E. Rockaway, L.I., N. Y.—130-page catalog*—Complete line of precision instrument parts available from stock is described and illustrated in Catalog No. 11. Items in the line include shafts, drives, couplings, bearings, adjustable cam assemblies, pulleys and belts, gear assemblies and development kits. Ordering information, specifications and catalog numbers are given for each item.—*Circle 594.

613. Hydraulic Power Units

J. N. Fauver Co. Inc., 49 *W. Hancock, Detroit* 1, *Mich.—8-page bulletin*—Photographs of custom designed power packages, hydraulic reservoirs and test stands are included in Catalog H-257. Blueprint sketches of standard power units and their accessories and specifications are also given.—*Circle 613.

603. Tube Fittings

Tube & Hose Fittings Div., Parker Appliance Co., 17325 *Euclid Ave., Cleveland* 12, *O.—52-page catalog*—Line of Triple-Lok tube fittings which feature leakproof operation under conditions of high pressure, severe vibration and extreme temperatures is described and illustrated in Catalog 4310. The fittings are available in brass, steel, stainless steel and aluminum, and in shapes including a swivel nut type and straight threaded fittings with O-rings. Photographs, complete specifications and weight charts are given.—*Circle 603.

609. Automatic Handling

Prab Conveyors Inc., 30121 *Groesbeck Highway, Roseville, Mich.—52-page catalog*—A variety of handling applications is covered by line of elevator and conveyor equipment described in Catalog No. 500. One model, the Magnavator, is a completely automatic elevator for handling small parts magnetically. Totally enclosed bulk material handling conveyor, the Tube-Veyor, is illustrated and discussed. Parts feeders, and custom built conveyor equipment such as bucket elevators, belt conveyors, vibrators and vibrating conveyors, etc. are also pictured.—*Circle 609.

602. Air Line Accessories

Arrow Tools Inc., 1900 *S. Kostner Ave., Chicago* 23, *Ill.—20-page booklet*—Filters, lubricators, regulators and drain traps are included in line of pneumatic accessories described and illustrated in booklet. Autopneumatic control which comprises filter, Aquamatic drain trap, regulator and lubricator, provides automatic control for all applications of compressed air on pneumatic equipment and devices. Photographs and specifications are given for various models.—*Circle 602.

591. Servomotors

Norden-Ketay Corp., Commerce Rd., Stamford, Conn.—10-page bulletin—Information on standard and custom servomotors available from company is contained in Bulletin #385. Data includes electrical and mechanical specifications. Typical circuits for direct plate-to-plate, transistor servoamplifier, and magnetic amplifier servomotor applications are shown and discussed. Synchros, motor tachometers, tachometer generators and gearhead servomotors are also mentioned.—*Circle 591.

605. Control Systems

Servo Corp. of America, 20-20 *Jericho Turnpike, New Hyde Park, N. Y.—16-page booklet*—Servosynthesis equipment, remote temperature control devices, infrared components and accessories, radio communication systems and automatic airborne navigation system are discussed and illustrated in Short Form Catalog SF 9901. Photographs and a brief description of each type of equipment are included.—*Circle 605.

618. Marking Machinery

Jas. H. Matthews & Co. Inc., 3942 *Forbes St., Pittsburgh* 13, *Pa.* — 8 *looseleaf pages of data*—Three production marking machines are the subject of illustrated pamphlets. Model 201 automatic rotary table marking machine is illustrated and described in pamphlet 146-C9; pamphlet 146-C10 discusses Model 79 automatic shell marking and knurling machine. Model 222 nameplate marker is covered in pamphlet 146-C17.—Circle 618.

616. Director Systems

Sensory Inc., New Vernon, N. J.—4-page pamphlet—Line of package controls which are custom designed for user requirements is discussed and illustrated in Bulletin 571. The controls direct a mechanism to perform a function at a specific time, and can be combined with Sensor units to check the performance of the function. Components of the system are briefly described.—*Circle 616.

626. Cylindrical Grinders

Landis Tool Co., Waynesboro, Pa.—28-page catalog—Line of standard and special purpose precision cylindrical grinding machines is the subject of Catalog CG-56. Special purpose models include hydraulic grinders for cam contours, multiple wheel applications, crankpins, concentric grinding, valve faces and raceways. Photographs and specifications of each model are included.—*Circle 626.

629. Hot Melt Adhesives

United Shoe Machinery Corp., Industrial Sales Div., 140 *Federal St., Boston* 7, *Mass.—6 looseleaf pages of data*—Coiled form of thermoplastic adhesive called Thermogrip is described and illustrated. Also discussed is the Model A applicator which is designed for the continuous and controlled feeding, melting and applying of the adhesive. Applicator can be attached to existing packaging or film and paper converting machines.—*Circle 629.

617. Plating & Processing

Meaker Co., 1629 *S. 55th Ave., Chicago* 50, *Ill.—8-page bulletin*—Low-head side-arm automatic plating machine, an automatic plating and proc-

*For Inquiry Card, see page 17

essing machine, and an automatic barrel plating machine are described in Bulletin 856. Photographs and cross-section drawings illustrate each machine. Features such as drives, construction, indexing, lubrication systems and draining are also discussed. —*Circle 617.

624. Air & Vacuum Pumps

Leiman Bros. Inc., 102 *Christie St., Newark* 5, *N. J.*—16-*page booklet*—Construction details, dimensions, capacities, performance curves and installation information on line of rotary positive air and vacuum pumps, gas boosters and air motors are given in booklet. The line includes two and four-wing types; fan-cooled, water-cooled and radiator air-cooled models; motor driven units; direct coupled and belt driven types; and automatically controlled tank units.—*Circle 624.

615. Vacuum Filter

Dept. FM-471, Industrial Filtration Co., Lebanon, Ind.—4-*page pamphlet*—Used in the filtering of coolants, cutting oils, solvents and all liquids requiring the removal of minute particles, tubular screen vacuum filter is the subject of illustrated pamphlet. Units are equipped with conveyor flights for the automatic removal of filtered solids, and are designed to meet the requirements for low micro-inch finishes.—*Circle 615.

623. Centralized Lubrication

Lincoln Engineering Co., Div., McNeil Machine & Engineering Co., St. Louis 20, *Mo.*—8-*page bulletin*—Air, vacuum and manually operated centralized lubrication systems are the subject of Bulletin No. 811. Air-operated systems have applications ranging from buses to automated lathes and packaging machinery; vacuum-operated systems can be used on light trucks and automobiles. Photographs illustrate typical installations. Various types of pumping units, alarm devices and central pump priming systems are described.—*Circle 623.

628. Roll Feeds

Wittek Mfg. Co., 4305 *W. 24th Place, Chicago, Ill.*—24-*page catalog*—Used for the automatic feeding of punch presses, line of roll feeds is illustrated and described in catalog. Available models include single, double, compound and special roll feeds. Photographs of several roll feeds are included; accessory items such as reel stands and stock straighteners are also covered.—*Circle 628.

627. Tube Mills

Yoder Co., 5500 *Walworth Ave., Cleveland* 2, *O.*—64-*page catalog*—Use of tube mills in the manufacture of pipe and tube is the subject of catalog entitled "Electric Resistance Weld Tube Mills." Step-by-step description of the electric weld process beginning with the roll forming and shaping of the tube through to the finished product is given. Photographs, drawings and charts illustrate the operation, capacities and applications of tube mills.—*Circle 627.

630. Vacuum Pumps

F. J. Stokes Corp., 5500 *Tabor Rd., Philadelphia* 20, *Pa.*—28-*page catalog*—Used in high vacuum degreasing and refinement of steel, copper and other metals; evaporation of metals and metallic salts; high vacuum sealing of containers, etc., line of rotary mechanical vacuum pumps is described in Catalog 752. Specifications, formulas, constants and conversion factors used in vacuum processing are given; solutions to pump selection problems and information on continuous oil purification are also included.—*Circle 630.

*For Inquiry Card, see page 17

LIAD 2-in-1 Control Instrument

- Analog-to-digital converter.
- Multi-contact meter-relay permitting control action at up to 64 points.

4″ x 2″ x 4″ approx.

Applications for the LIAD (Low-Current-Analog-Digital) include telemetering, automatic testing, sorting, reading of maximum values, and accumulating quality control data.

It has a D'Arsonval movement, operating from any sensing element. A printed circuit scale replaces the normal dial. Read-out takes place when contacts under the pointer are clamped to the scale.

The LIAD converts low-level signals for transmission over great distances. Accuracy with a six-band scale is 1 part in 64. Fastest operation is about two times a second.

ASSEMBLY PRODUCTS, INC.
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West Coast: Box XX Palm Springs 27, California
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WesCo miniature solenoids...

do big jobs in small space

- Completely tested
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- Mounting furnished to meet your requirements.
- Hundreds of other designs for both AC and DC application.
- Push or pull units to 200 lbs. force.
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mill
drill
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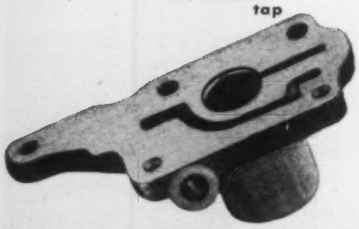
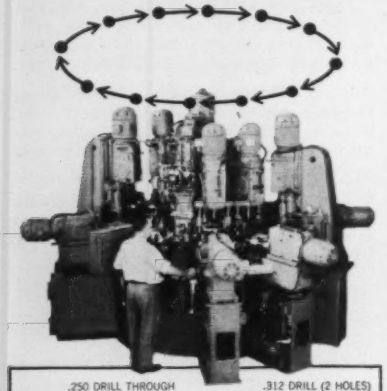
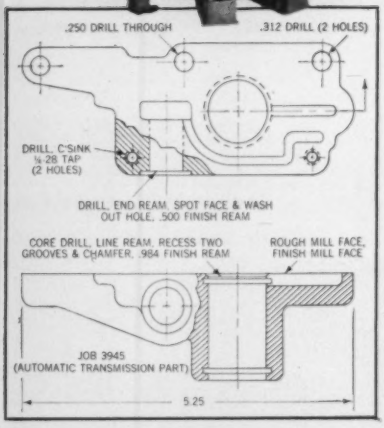
recess
spot face
countersink
tap



200 PER HOUR GROSS




.250 DRILL THROUGH
.312 DRILL (2 HOLES)
DRILL, C'SINK ⅛-28 TAP (2 HOLES)
DRILL, END REAM, SPOT FACE & WASH OUT HOLE, .500 FINISH REAM
CORE DRILL, LINE REAM, RECESS TWO GROOVES & CHAMFER, .984 FINISH REAM
ROUGH MILL FACE, FINISH MILL FACE
JOB 3945
(AUTOMATIC TRANSMISSION PART)
5.25

This Kingsbury has a central column and 12 stations, and 13 automatic operating units. Clamping and unclamping are automatic. All units operate at the same time, while the operator is changing parts in the fixture.

Most Kingsburys are less elaborate. But all have the same purpose:

uniform operations
at a high production rate
to the customer's specification
at low unit cost

May we get together on one of your jobs, simple or complex? Kingsbury Machine Tool Corporation, Keene, N. H.

KINGSBURY

INDEXING AUTOMATICS for high production drilling and tapping

Circle 722 on Inquiry Card

AUTOMATION • problem forum

Readers with problems concerning systems, equipment or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Solution suggestions should refer to case number and title of the problem involved.

Case No. 1076-P
Automatic Inspection Machine

. . . We are attaching a print giving the outline dimensions of a new type of thermal switch that we will soon be producing.

Since we anticipate that the demand for them will be considerable, we are looking for a company to undertake the design and the construction of a machine to automatically verify the calibration of these switches. A typical temperature setting would be: Open 250F ± 5 degrees; Close 220F ± 7 degrees.

We would appreciate it very much if you would furnish us with the names of companies who might be qualified to undertake this development for us . . .

Asst. Chief Engineer

♦ ♦ ♦

Case No. 1037-P
Moisture Control

. . . We would appreciate any information as to the availability of instruments to do the following: Continuously sample the moisture of a granular material and continuously control the flow of water being added to result in a mix of constant water content.

Specifically, the finely ground material moves on a belt and discharges through a water spray into a mixing chamber. Before it is sprayed the material may vary in moisture content from near 0 to 5 per cent. The mix should have a water content of about 12 per cent . . .

Vitreous Item Producer

♦ ♦ ♦

Case No. 1199-P
Tinning Brush Leads

. . . We have a problem on soldering the free ends of braided leads. The operation is referred to as dipped ends. The operation done at present is as follows:

1. Twist end of braided lead
2. Dip end in flux
3. Dip end in solder.

The operator does 1080 pieces per hour on incentive.

We manufacture about 3,000,000 pieces per year. Please send us suggestions on how we might automate this operation . . .

Project Engineer

♦ ♦ ♦

Case No. 1017-P
Pneumatic Sand Conveying

. . . We are interested in a pneumatic conveyor to handle prepared molding sand in our iron foundry. We know of one source in Chicago, but would appreciate it if you could advise us if there are any additional sources for this equipment . . .

General Purchasing Dept.

♦ ♦ ♦

Suggestions For 1078-P
Water in Oil

. . . Phillips Petroleum Co. has developed a capacitance measuring instrument, called a Permittor, for level control, for measuring water in hydrocarbons in ppm range, and for monitoring the water content in crude oil. This instrument was originally designed to measure minute quantities of water in pure liquid hydrocarbons. A less sensitive model was later developed for the measurement of water in crude oil.

In custody transfer service, the Foxboro Capacity Dynalog and the Gulf Monitor, designed by Gulf Research & Development Co., have also been used to limit water content in oil to 0.5 per cent. These instruments have been in service for several months and have been found to be very stable and accurate.

I trust this information will be helpful and if we can be of further service please do not hesitate to let us know . . .

Carstens Slack
Phillips Petroleum Co.

♦

. . . A pamphlet describing Instruments Inc. equipment to detect the presence of small amounts of water in liquid hydrocarbons is enclosed. You may pass this on to your reader if you wish, but I would appreciate your mentioning its source to him . . .

J. J. Combes
Scientific Design Co. Inc.

CAKE MIX IN A "JIFFY" WITH

CYPAK

Controlling automatic storage conveyors at Chelsea's modern food plant

Chelsea Milling Company, maker of well-known "Jiffy" brand premixed foods, uses flexible CYPAK* static control to reduce material handling costs in their plant at Chelsea, Michigan.

CYPAK begins at the mixing and packaging machines, memorizing the sequence of cartons going to the warehouse. Cartons are identified automatically, and then CYPAK directs storage according to the preselected pattern.

Subsequent delivery of cartons from storage to dock is also completely predetermined, making the warehousing operation totally automatic. An additional benefit realized by Chelsea with this system has been great reduction in carton breakage.

For complete information on CYPAK, call your Westinghouse representative, or write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

*Trade Mark
J-22033

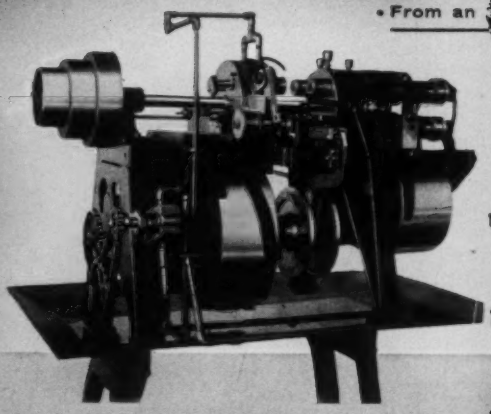
YOU CAN BE SURE...IF IT'S

Westinghouse

Mr. Lester L. Bosch, Partner, Bosch & La Tour views their system design.

Thanks, Mr. Keebler...

You have said it better than we could!



First successful multiple-spindle automatic—the granddaddy of *all* of today's "multiples"—developed and built by National Acme in 1893.

• From an editorial in April, 1957 **AUTOMATION**

by JAMES C. KEEBLER, Associate Editor

this tubing annually that the price

Those who think of automation only in terms of production techniques developed since Harder first uttered the magic word *Automation* are thumbing right past a few useful rules. If we aren't careful these newly trained manufacturing engineers will be overlooking a few tricks that have been in the trade since Hector was . . .

Overpublicizing the new developments might overshadow the fact that the methods developed long ago fit the pattern of present-day automation techniques and therefore should not be overlooked in evaluating possible production processes.

A case in point is the automatic screw machine used on these bearing rings. This machine development was placed on the market in the 1890's and incorporated such sound basic automatic machine thinking that it remains primarily the same in principle in its 1957 model.

On these machines are performed in succession and without manual attention virtually all of the circular machining operations required on ball bearing rings. This is automation. Just because the technique is not new is no reason why it should not be given its just place in the galaxy of automation studies.

more ors, air , etc., bear- ulti- ear ber igh ound ern to Inner m le used

• History has recorded the machine tool development about which Mr. Keebler writes as the direct prototype of present day Acme-Gridley Multiple Spindles—in fact, it's the granddaddy of *all* of today's "multiples".

• Since the inception and development in 1893 of the first successful Four Spindle Automatic Screw Machine, National Acme has extended the inherent circumferential automation principle of its basic design to six and eight spindle machines. These machines have set the pace with which to meet, head-on, industry's need for greater and less costly production.

• Knowing that the future will make ever greater demands on circumferential automation, National Acme will continue to expand applications for Multiple Spindle Automatics. Who knows?, some day the line may include not only 4, 6 and 8 spindles, but 12 and 16 spindle machines as well.

National Acme

THE NATIONAL ACME COMPANY, 170 E. 131ST ST., CLEVELAND 8, OHIO • Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.

RELIABILITY AS A DESIGN PARAMETER

By H. L. GARBARINO
Armour Research Foundation
Chicago, Ill.

THE PURPOSE of this paper is to review the problem of reliability in electronic equipment and to show how reliability and life are related to the parameters of components and systems. It is recommended that reliability should be considered as a design parameter along with performance requirements and environmental conditions, and should be taken into account when components or systems are being developed or applied.

In the last ten years there has been a tremendous growth of interest in the problem of obtaining improved reliability and most of this interest reflects problems encountered with electronic equipment. However, there are many products and industrial processes where reliability and life of equipment have long been important considerations. The major class has been control or signal equipment where continuity of service is extremely important. Reliability has been required because of high economic costs of a failure or because of human safety considerations. More recently, efforts to obtain better reliability have been motivated by the problems of electronic computers using many components, and of military electronic equipment.

It has long been appreciated that a sacrifice in initial reliability levels may have to be paid for with high expenditures for maintenance. These may be several times the original cost during the life of the equipment. Another factor is that reliability considerations can simply not be avoided in equipment or systems using a large number of components.

The concern with reliability problems in the last ten years has led to very definite progress in one respect; there are now concepts and techniques available for defining and measuring reliability levels. There have been enough data accumulated to demonstrate that populations of components or systems can be expected to fail in some manner as a function of time. Progress has been made in applying principles of probability to the problem. It has been recognized that the possibility of equipment failure must be accepted, and the problems are to find out what the rate of failure is and how this rate, if excessive, can be reduced to a reasonable value.

Data obtained by various investigators indicate that equipment may fail for two major reasons: either because components are defective in terms of materials, design, or manufacture; or because of an unsatisfactory application of a component or system for meeting the given requirements. It might be questioned whether a component or subsystem is of a suitable general type or whether

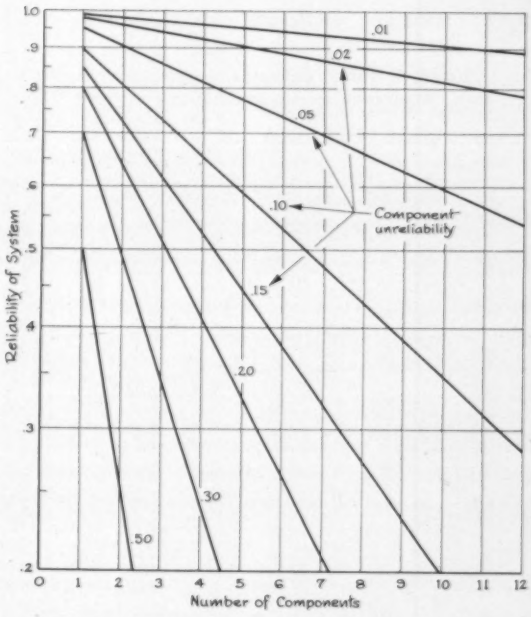


Fig. 1—Plot of system reliability as a function of number of components and component unreliability levels.

it has an adequate rating to withstand the various stresses encountered. In all likelihood it is a suitable type of component, but its rating is inadequate.

The Reliability Problem

A major factor in the overall reliability problem is the difficulty of getting adequate, accurate information on component or system failures. Cor-

How to cut costs of handling small parts:

Start with a

Feedall

AUTOMATIC TRANSFER CONVEYOR

for fully mechanized operation

USE THIS MACHINE

Wherever faster delivery, feed or transfer of small parts means real time-saving.

Wherever continuous flow of parts between production machines cuts costs.

Wherever fully automatic parts handling saves manpower, speeds production.

Specifications, MODEL 1600B
RANGE: handles parts 1/4" to 2-1/4" dia.; length to 62-1/2".
CONVEYOR: standard model has 1-3/4" frame width.
SPEED: variable drive, 5 to 20 feet per minute.
DRIVE: 1/4 H.P. three-phase. 220-440 volts.

Moving small parts between production machines slows down output. You have to do extra handling. That takes manpower, increases costs. But with Feedall's Parts Transfer Conveyor, *the operation's fully automatic.*

Model 1600B is a totally self-contained and automatic unit. It provides high-speed delivery, feed or transfer of small parts between centerless grinders, milling machines, presses, induction heating machines and similar production operations. Variable speed drive permits a perfect match with any desired flow rate. Other features include heavy steel side-plates, nylon bearings, simple installation, heavy-duty long-life construction, minimum maintenance and very low operating cost.

For Practical Help: write or phone for detailed information in latest catalog and including estimate data sheet. Tell us your parts feeding problems and let our experienced engineers help you cut costs.

Feedall

Designers and Builders of Automatic Feeding Devices
FEEDALL, INC. • WILLOUGHBY, OHIO

BLADE, ELEVATING, ROTARY AND VIBRATORY FEEDERS ELEVATING TRANSFER CONVEYORS, SPECIAL SELECTOR DEVICES

rect information is extremely essential for making intelligent attempts toward improving system components or for substituting more suitable ratings. This essential information can be gained in part from quality control procedures and general engineering data on the product. It can also be obtained from field data relating failures to the specific application, the operating environment and the times involved for storage, shipment, and actual operation. Thus failure data are principally available from laboratory tests or inspection processes before normal operation and from failure reports prepared at almost any time after shipment. Criticisms have been made that laboratory data are not realistic, and failure reports are incomplete and inaccurate. However, there has been greater confidence placed on laboratory test results. There have also been notable attempts to obtain the large quantity of life-experience data which are so desirable for a good statistical approach but which require a prohibitive amount of laboratory testing. Historically, there have been many attempts to improve reliability with very little information on failures, and much effort has been wasted on the less important factors.

Several types of failure are generally possible for a component or system. One type is referred to as a total or catastrophic failure and makes the equipment completely inoperative. Another type of failure is the degradation of a component or system such that performance in one or more respects falls outside of normally acceptable limits. For the purpose of this discussion, a reference to failure will mean either type. It might be noted that total failure of a component may result only in degradation of a system in which it is used. Other possibilities are obvious in which total or partial failure of a component does not necessarily cause total or partial failure of the equipment. It is conceivable this lack of correlation may indicate that specific requirements for the component or system are not very realistic. A third type of failure, intermittent operation, might be mentioned.

Reliability Functions

Some of the previous studies of failure statistics indicate which types of components cause the most failures. In general, it has been found that components are responsible in approximately the following order: tubes, resistors, capacitors, connectors, switches, relays, transformers or inductors, meters and motors. Failure rates, or ratio of number failing to the total number of the component type, are not in accordance with the foregoing order because of different quantities of the different components being used in typical electronic equipment. It has been estimated that approximately one-third to one-half of component failures are represented by tube failures. This might imply that tubes present the greatest problem, but it should be appreciated that other components normally require much more maintenance time for

detection and replacement than do tubes. Thus, a proper balance of efforts to obtain improved reliability should place sufficient emphasis on components other than tubes, and particularly on resistors, capacitors and connectors.

In seeking to establish techniques for predicting reliability levels and in comparing different types of components and equipment, it is very desirable to find how failures are likely to occur as a function of time and system complexity. It is relatively easy to obtain values of overall reliability from component reliabilities for a system in which the failure of one component will cause the system to fail. System reliability is given by the following equation, which assumes that failures of the system components are independent of each other for the determination of each component reliability level:

$$R_T = R_1 R_2 R_3 \ldots R_n \quad \ldots\ldots (1)$$

where R_T is total system reliability or probable fraction of identical systems surviving beyond an arbitrary time t, R_n is reliability fraction of the n-th component. If the reliability of all components are the same,

$$R_T = R^n \quad \ldots\ldots (2)$$

where n is the number of components.

This function for different values of component *unreliability*, which is equal to $(1 - R)$, is plotted in *Fig.* 1 for a system having relatively few components. It can readily be shown algebraically and verified from the figures that when the system reliability is in the order of 0.8 or more, then system *unreliability* or the quantity $(1 - R_T)$ is approximately equal to the number of components times the component unreliability level. Thus a system with 10 components at the 0.01 level of *unreliability* has a system *unreliability* of 0.1 and a reliability of 0.9. Also, the overall failure rate is given by the sum of the individual component failure rates.

Next consider different modes of failure. One of the most commonly found distributions of physical data is the normal or Gaussian. This distribution is characterized in part by a set of data having most items near some mean value and a symmetrical distribution about the mean. However, the normal distribution which approximates so many physical distributions is only rarely applicable to electronic components or equipment, and for this reason will not be considered further. Instead, it has been found that the best simple function to approximate most failure data is obtained merely by considering the failure rate as a constant. Mathematically this gives the following equation for reliability:

$$R = e^{-qt} \quad \ldots\ldots (3)$$

where q is failure rate, t is time. The constant failure rate function is shown by the solid line of *Fig.* 2. One implication of this failure function is

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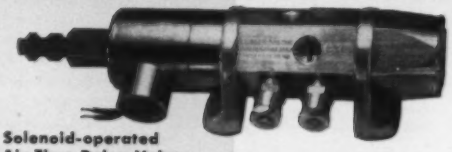

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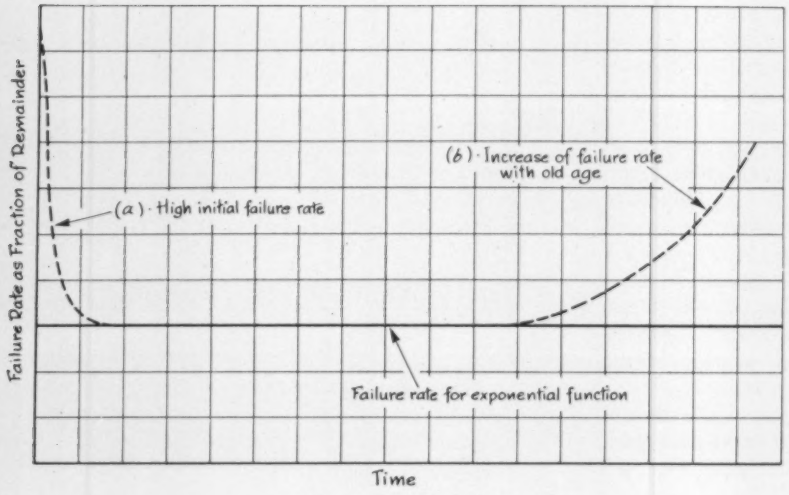
Failure Rate as Fraction of Remainder
(a) · High initial failure rate
(b) · Increase of failure rate with old age
Failure rate for exponential function
Time

Fig. 2—Failure rate functions. The solid line illustrates a constant failure rate. Dashed lines imply (a) high initial failures assignable to defective manufacture and (b) increased failures as service life is extended.

that failure rate is independent of age of the equipment. For a given population of components or systems which are all put into operation at the same time and subjected to similar conditions, it can be expected that the failure function will be modified such that there will be a high initial failure rate as the equipment is placed in service. This high initial failure rate may be presumed to be caused by defective manufacture and could possibly be reduced by suitable testing of the equipment before it is placed in service. Another modification in the simple function would be an increase in failure rate if the items of equipment have been in service for a sufficiently long time. These modifi-

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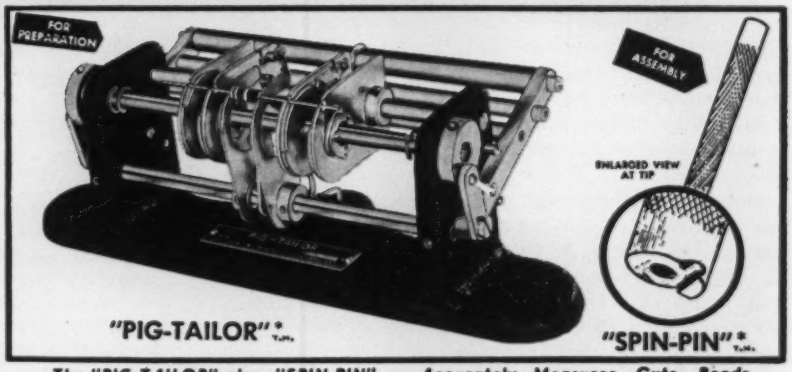

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cations of the constant failure rate function are given by the dashed lines in *Fig.* 2.

Reliability and Design Parameters

Values of reliability of specific components or systems are defined either by failure rate in a given time or mean time between failures. These values are determined by the materials, the design features, the manufacturing quality, and the environmental stresses. It is generally recognized that reliability can be increased by using more conservative design stresses or by more careful manufacture. However, it is often necessary to pay for improved reliability in terms of other quantities besides cost. We may pay for reliability in terms of performance, weight and/or size. In addition, reliability may be improved by duplication of components or systems or by incorporation of new elements which detect failures and then take some corrective action.

There are many interesting examples of how reliability may be improved by sacrifice of performance. One of these is the incandescent light bulb, in which life may be increased by reducing voltage; but light efficiency is also reduced. Since power cost is many times the cost of the light bulb during an average life span, the reliability in this case is ultimately paid for in dollars. Another example of the relation between reliability and performance has been described by O'Neill and Acheson, who point out that reliability of electron tubes might be improved by means of a sacrifice in mutual conductance, which would be reduced by increasing spacing of the electrodes. Yet another example has been given to show how the tolerances in resistance values of resistors may be reduced by derating the resistor.

Examples are very common which show that reliability, in terms of expected life, can be increased at the cost of size and weight. Many electronic components generate heat which makes their operating temperature higher than the temperature of the environment. In general if the size of such a component is increased, the temperature rise over ambient is decreased, and conversely. This is very significant because temperature is the major environmental factor affecting life of many components including resistors, inductive apparatus, tubes and others. For capacitors one of the major application factors is applied voltage, and as the voltage stress is reduced expected life will normally increase. These examples show the importance of considering expected life in the design and application of components and systems. An awareness of these relations is the first step in establishing reliability level as a design parameter. In some instances a sacrifice in performance to achieve reliability may have been made needlessly or unknowingly, and an evaluation of all factors could indicate a desirable change in a design.

Consider certain fundamental but approximate relations between expected life and operating

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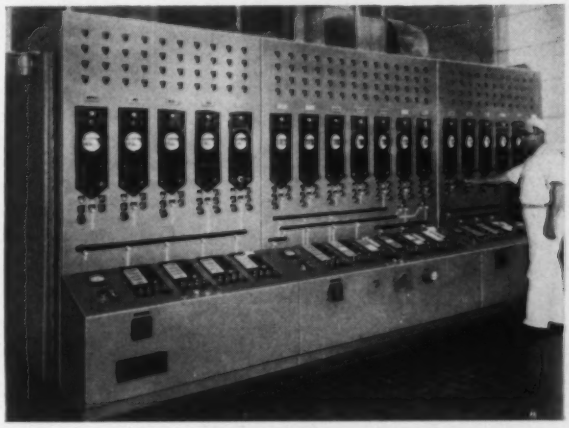

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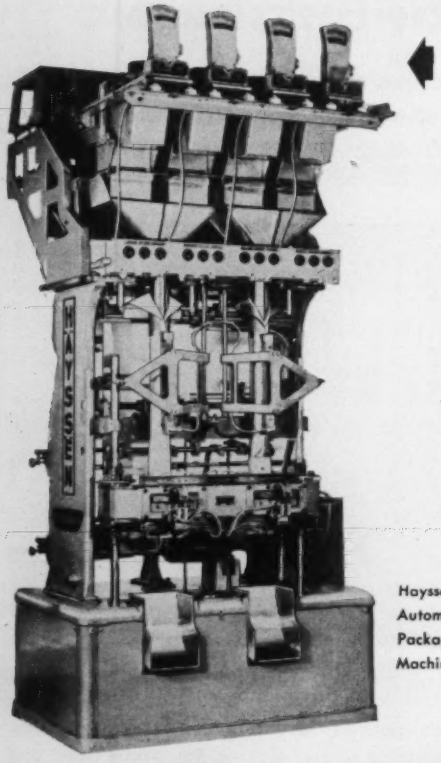
A report on Exact Weight Scales in Automation



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stresses: There is a widely known empirical relation between the life and applied voltage across a capacitor dielectric. The relation states that life is inversely proportional to some higher power of the voltage, with a typical value of the exponent being five, as given in the following:

$$t = t_0(V_0/V)^5 \quad \ldots\ldots\ldots\

LUBRICANT PROGRAM

By ROBERT A. MELTON
Divisional Plant Engineer
Chrysler Corp.

OVER THE YEARS, the problems associated with maintenance lubrication have been met by the development of many specialized lubricants devised specifically to satisfy the requirements of our new high-speed modern machinery.

As each machine was put into operation, the specific lubrication needs of that machine were provided by having a lubrication sales representative make recommendations of his company's products to meet the machine manufacturer's suggested lubrication schedule. Although we endeavored to restrict each vendor to a particular plant or area, it was unavoidable that multiple sources were ultimately supplying similar products for different applications throughout a single plant. Inadequate information on the interchangeability of these products made it necessary to maintain multiple stocks of essentially identical materials both in the stores inventory and in the maintenance areas.

In 1954 we had the opportunity of reviewing and revising our maintenance lubrication schedules to take advantage of the application of a few high-quality products bought to specifications devised to provide products capable of handling normal maintenance lubrication assignments. These specifications cover eleven viscosity grades of oil ranging from 70 seconds to 4500 seconds at 100° F. These grades are grouped as spindle oils, shop oils, hydraulic oils, compressor oils and press oils and in each group are grades which are designated with the usual light, medium, heavy, etc. These oils are supplied by various approved sources ranging from four vendors to ten vendors per grade and totalling 89 sources.

The improvement in our handling is immediately apparent since it is possible for us to have the same grade and quality of lubricant supplied by ten different vendors all under the same specification number and handled as one item on our stores and maintenance areas. Furthermore, in any one plant we did not necessarily have use for all eleven grades. Our Mack Plant for example uses seven of these eleven grades, but our Nine Mile Plant uses only three. In either case, the stores areas and the maintenance personnel now work with a specification number which is related to a particular viscosity rather than several vendors' different tradename designations.

For shop greases, our specification program provides two general purpose greases, whereas we previously had 33 different products in our Mack Plant to cover these applications. This is not to say that we use only two products; rather we may still have ten vendors' greases in the plant, but

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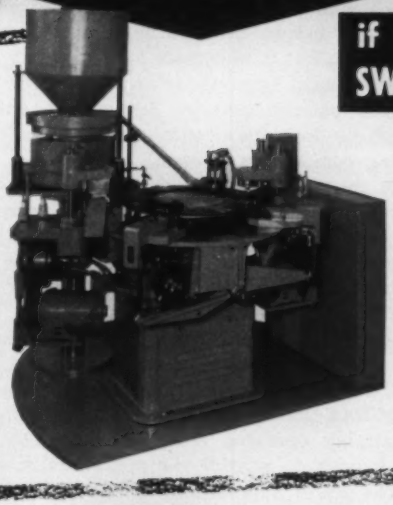

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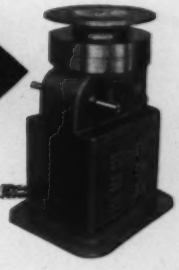

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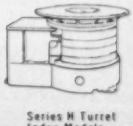

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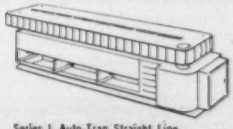

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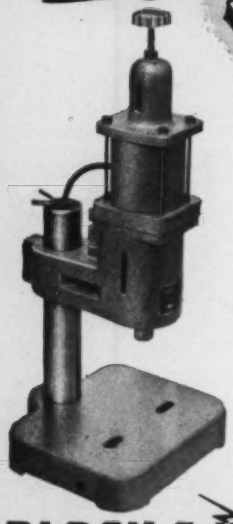

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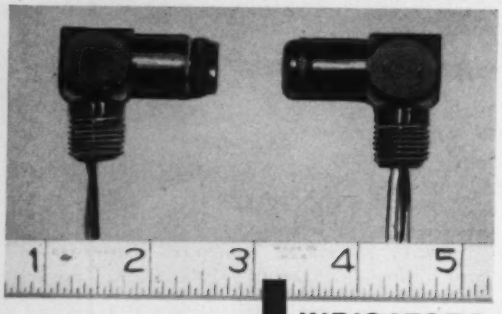

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From a paper entitled "Maintenance in Metal Fabricating Plants" presented at The Eighth Plant Maintenance and Engineering Conference, Cleveland, Jan. 1957.

MARKETING'S ROLE IN AUTOMATION

By FRANK B. JEWETT, JR.
Vice President
Vitro Corp. of America

MARKETING is a broad field which encompasses the entire process of sales and distribution in a free society. It includes market research, planning, selling per se, merchandising, advertising, promotion, and all the other specialties with which you are more familiar than I. My purpose is to challenge your imaginations by giving you some indication of the important part marketing experts must play if we are to realize fully the opportunity that automation presents to us.

I certainly do not wish to underestimate the difficulty of justifying the great capital investment which must be made in equipment and make-ready expenses before one can automate his marketing statistics. But it is certain that it is only a matter of time until someone in each industry finds the proper balance between investment and results. When he does, his advantage will become a devastating competitive weapon.

In the realm of materials handling, automation offers new possibilities for effecting economies and for providing greater service in distribution. It would be a mistake to view automation of materials handling merely as a means of replacing labor in the existing channels of distribution. The possibilities of mechanization provide a versatile tool for the imaginative marketing executive. By reducing direct labor to a minimum, for instance, he may find that certain retail outlets could be most profitably operated on a 24-hour-a-day, 7-day-a-week basis to provide the maximum in service.

The era of automation, it seems to me, will have a direct impact on both the methods and the means of marketing; primarily on consumer and other goods where volume is high.

Industrial marketing will also feel directly the results of automation in selling the product of automated manufacture. As a company automates its production, it supplants variable direct labor with the continuing liabilities of higher capital investment and more indirect labor for skilled main-

tenance and direction of the automated lines. In general, too, it incurs more rigidity in its production scheduling. Longer runs must be made between changes to realize the economies of automation.

These factors bring about subtle changes in the relationship of the marketing group with the other operating functions and in its problems and policies with respect to selling. This leads to the second aspect of automation that will exert a strong influence on marketing and distribution in the future.

Even far short of the fully automatic factory, automated production begins to assume a certain rigidity. Long runs, maximization of common subassemblies in various models, minimization of drastic yearly model changes, and so on, all become vital factors to the economic success of the automation program.

The same factors are, of course, important in conventional manufacturing processes. However, the further one carries automation, despite the cost savings it permits, the more *time*, rather than *labor*, becomes the principal item of cost. As the ability to vary production to meet demand decreases, the need to establish a continuous rate of consumption grows. The area of business risk shifts somewhat from manufacturing to marketing.

Internal Problems

These, then, are some of the internal problems you must face as your companies automate: You must have a better understanding of your product and the degree of flexibility permitted by your production system. Your product planning must be based on this knowledge. You will have to work in even closer concert with your engineering and manufacturing staff in seeking every means possible for complete utilization of available time in your production facility and to conceive new designs or new products which will meet the demands of both market and factory.

More accurate and longer range forecasts of future sales will be required because of larger fixed investments. Successful automation will be based on successful planning.

Each new investment in automation will require a firm and accurate commitment from you, the chief marketing executive, as to your ability to dispose of the product that will be produced for a period long enough to amortize the investment and at a rate great enough to return the predicted lower costs and higher profits. In no small sense the future of the company will rest in your hands more than ever before.

Automation will bring the marketing executive still another challenge, which is the third point I wish to make. As automation increases the dependence of production on a continuous market, it saddles the marketing executive with the responsibility of providing the continuous demand. He must plan his activity carefully, and far in advance, to insure his ability to deliver the goods. He must make sure that both consumer demand and the consumer's ability to satisfy his appetite

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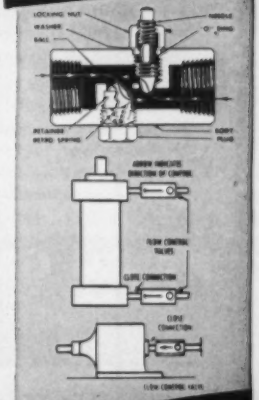

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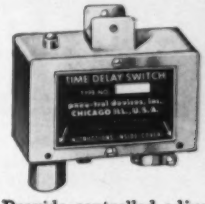

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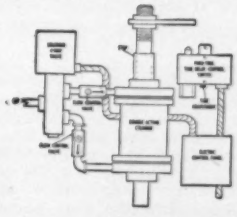

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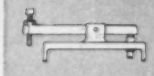
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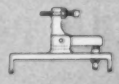
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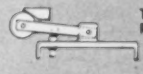
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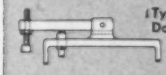
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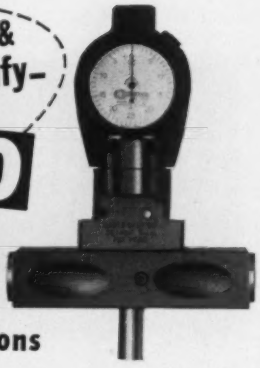

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are present in the proper proportions. The automated industry must keep running at high speed, year after year. The economic penalty for slowdowns will become greater the farther automation progresses.

The onus will be on the marketing executive. He must be satisfied that the product he will sell will meet the consumer demand. His final approval of the product is mandatory because he bears the responsibility for producing the sales volume which alone can justify the investment in automated production facilities.

It appears to me, therefore, that, increasingly, planning for automation in production must be preceded by planning for automation in marketing. To place the cart before the horse may well jeopardize the entire enterprise.

Implementation

So much for the "musts." Now, what can be done about them? The problem is simple to define, not quite so simple to solve. A large continuing demand must be created and a concurrent ability to purchase must be maintained. To create the demand, the marketing executive must first have an appealing product to sell. He must then pull every stop in his organ of advertising, promotion, and merchandising to put his product over.

But more than that, he must be able to re-sell his original customers within a finite period, probably within a period less than the real life of his product. To do this, he must create a demand for his new product based on new styling, new features, or technological improvements. Service policies and organizations must be overhauled to reduce the possibility that dissatisfaction with yesterday's purchase will prevent tomorrow's. All this suggests a well-planned, long range program of product development in which marketing plays a strong part.

It also leads to the obvious conclusion that the marketing executive must also provide some means of enabling his original customers to dispose of their original purchase before it is worn out so that they can buy again. He may choose to foster an organized second-hand market. It may be better to offer a high trade-in value and junk the used goods. Perhaps he might lease new equipment with the provision that a new model would be supplied every so many years. Above all, he must stimulate man's craving to have.

There is nothing new in what I have just said; the process has already been proved fabulously successful. This philosophy of automation is what enabled the automobile industry to parlay a powered box on wheels into a gigantic replacement demand bonanza. By this means, it justified the high degree of automation that we now accept as characteristic of automobile production.

If your company is looking at automation in its production activities, these are the challenges that lie before you, the marketing executives. I am sure that each of the points I have made will be recognized as good marketing practice today. My ob-

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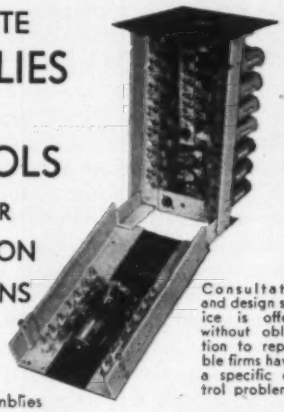

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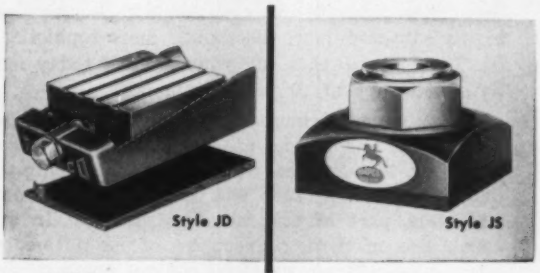

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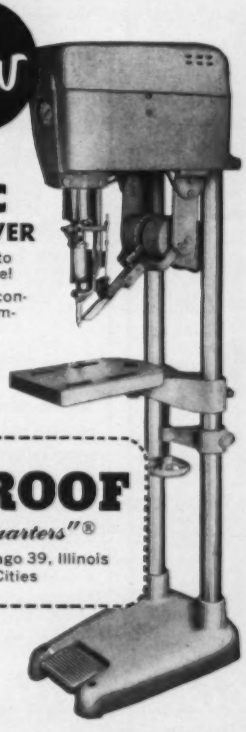

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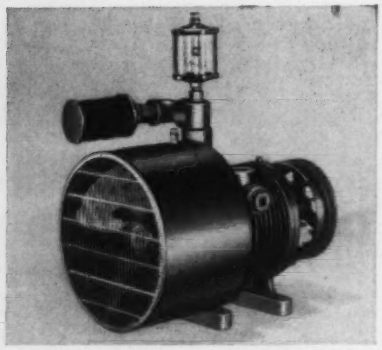

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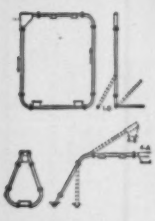

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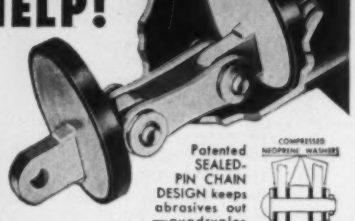

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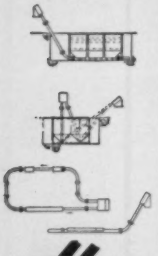

Move almost any flowable material—wet or dry—through any plane or angle . . .

Make *big savings!* Move bulk materials *automatically*—up, down, through walls, around corners and obstacles with a Hapman! Circuits like these or complex layouts engineered to *your* needs. Usually a *single* drive unit serves where other conveyors need several. Design cuts costs. Dust and liquid *tight!*

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ject, however, is not to suggest that they are new, but to stress that automation will increase the importance of the marketing function and each of its specific aspects in bringing success to the enterprise.

So much for the direct impacts of automation on marketing. Now let us consider the indirect implications. Automation is the fundamental base upon which our continually increasing standard of living rests. As the experience of the chemical, automotive, and other highly mechanized industries proves, with automation go higher wages and salaries. These increased incomes are the purchasing power which you must tap to maintain the consumption that automation requires.

Automation will provide you with more and more opportunities of finding new ways to stimulate and satisfy the insatiable demand of the buying public.

The rising incomes which automation will produce will also accentuate home ownership and the movement to suburbia. Your market for the things a homeowner wants will expand far faster than the population statistics would indicate. Country living and higher incomes probably also imply larger families and a more decentralized market. Fortunately, automation carries with it certain possibilities for flexibility of plant location. Where shifts in the locations of markets and sources of raw materials are probable, it may be possible to create production facilities that can be moved economically.

The demands of automation will gradually raise the skill and educational requirements of our entire labor force. You have already heard the great clamor for more and better trained engineers. As this action proceeds, your market will become more highly educated, more discerning, more sophisticated. The features that sell your product today may have little appeal 10 years from now.

As automation increases the economy of our production, and as the general standard of living in the world increases, we may well anticipate the day when foreign trade will become a much more important part of our industrial market. In any event, the marketing executive of an automated business should not overlook the potentials of foreign markets.

The main points I wished to make were: First, that automation will be a powerful and healthy force in our society during the next two to three decades. Second, that automation will have a tremendous impact on marketing functions, both directly in the methods and tools of marketing itself and indirectly by causing changes in consumer attitudes and the nature of the market. And finally, that marketing itself must play a vital role in the development of automation processes. In my opinion, marketing is the key to success in automation.

From a talk entitled "Marketing—The Key to Successful Automation" presented by E. B. Hotchkiss, vice president, Vitro Corp. of America, to the Toronto Chapter of the American Marketing Association, Toronto, Jan. 1957.

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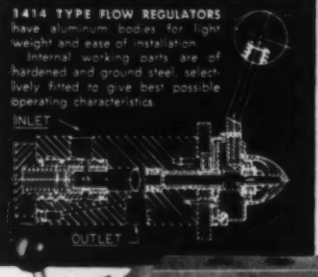

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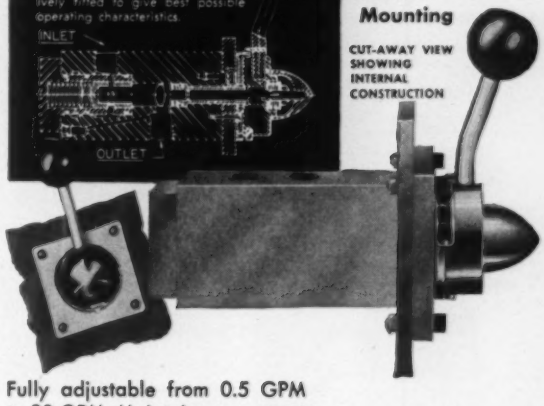
Designed for Panel Mounting



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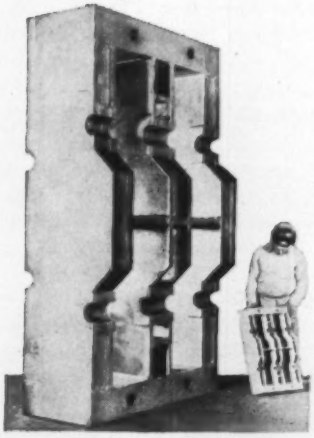

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patents

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DIVERTING MEANS FOR CONVEYOR SYSTEM

Metallic objects traveling on a conveyor are selectively diverted to auxiliary slides by use of magnetic elements. Patent 2,776,739 by Martin J. Wilcox.

APPARATUS FOR MEASURING SURFACE SPEED

Surface speed of a moving object is measured by determining phase difference between a varying signal recorded on the object and the signal picked up by a head at a fixed distance from the recording point. Patent 2,786,978 by Roger M. Warner, assigned to Champion Paper & Fibre Co.

APPARATUS FOR HANDLING STRIP

Strip from a high speed strip processing line is coiled on one of three mandrels. At least two of the mandrels can also act as uncoilers to feed the strip to a succeeding low speed line. Patent 2,779,550 by Earll R. Muddiman, assigned to United States Steel Corp.

TAPE CONTROL FOR LINE CASTING MACHINES

Plurality of central circuits for an electrotype-setting machine are sequentially actuated by a plurality of tapes in the casting of a single line. Patent 2,788,886 by Herbert L. Paulding and Richard T. Yu, assigned to Dow Jones & Co. Inc.

HIGH SPEED MAGNETIC SWITCH

Switch for scanning a plurality of circuits includes a rotatable arm with a magnetic pickup and a plurality of magnetic heads in close proximity to the circular path of the pickup. Patent 2,786,182 by William J. Herbert, Everett E. McCown and Seymour S. Levine.

APPARATUS FOR CONVEYING AND STOPPING RAPIDLY MOVING METAL SHEETS

Rapidly moving sheet fed into equipment is stopped by frictional and magnetic forces. Deenergizing of the electromagnets used then allows sheet to drop. Patent 2,779,594 by Dario Buccicone.

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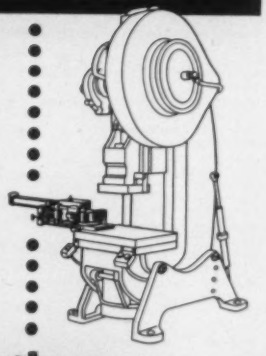

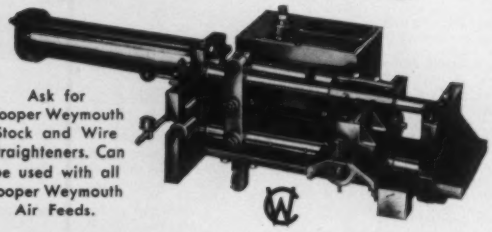

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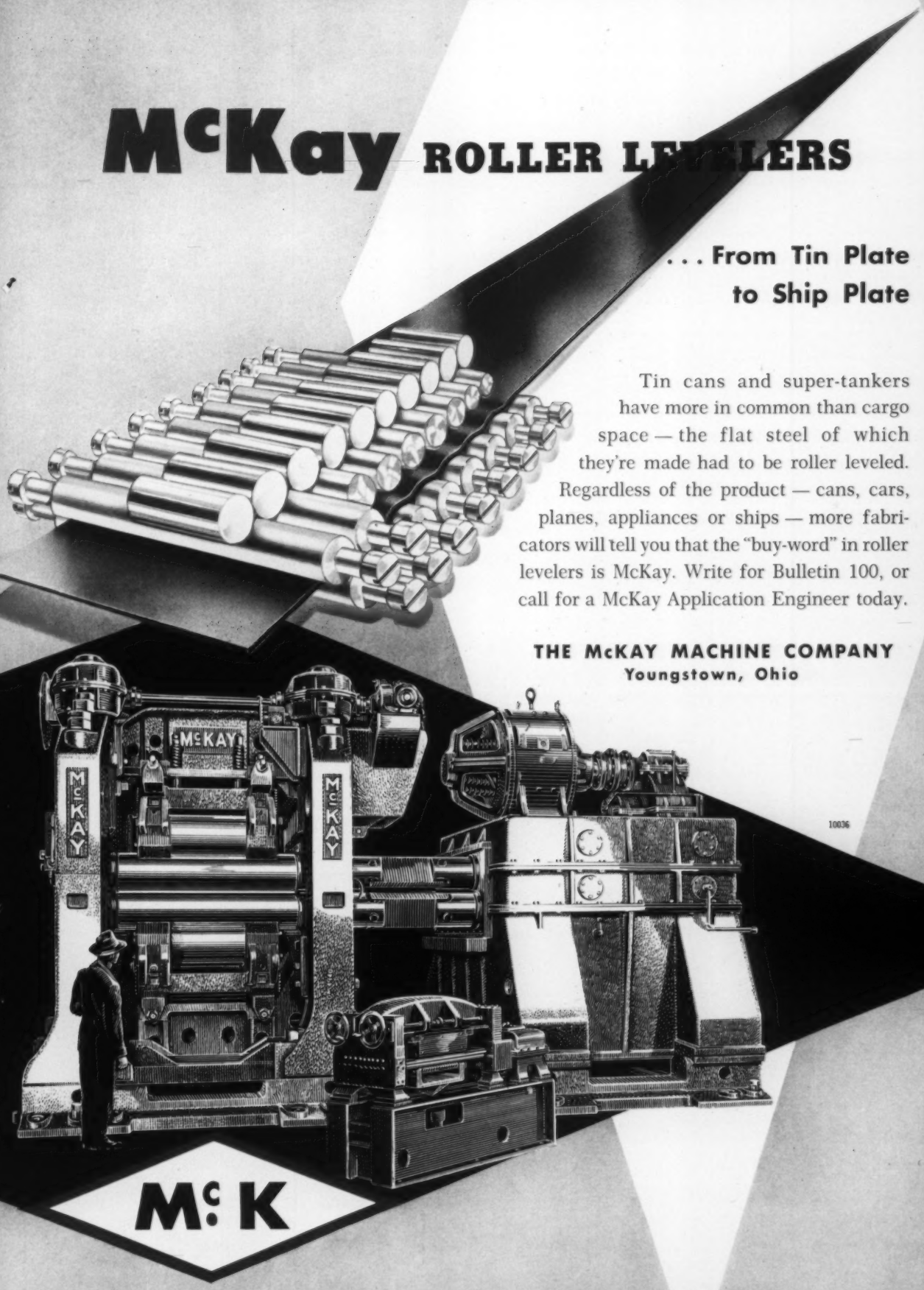

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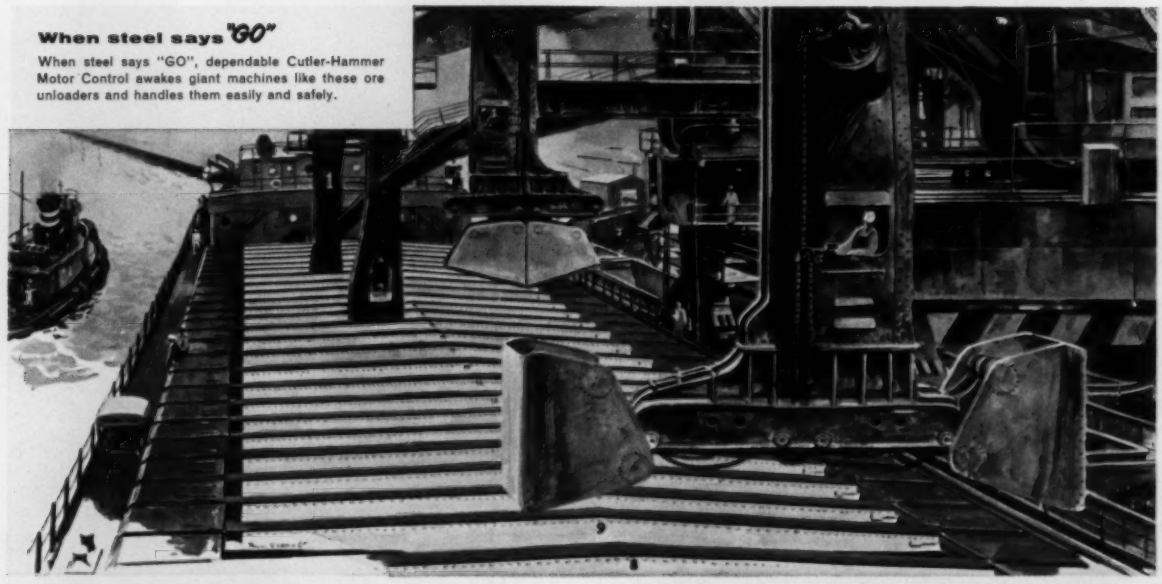

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